FEBRUARY 1956

THE WELDING JOURNAL

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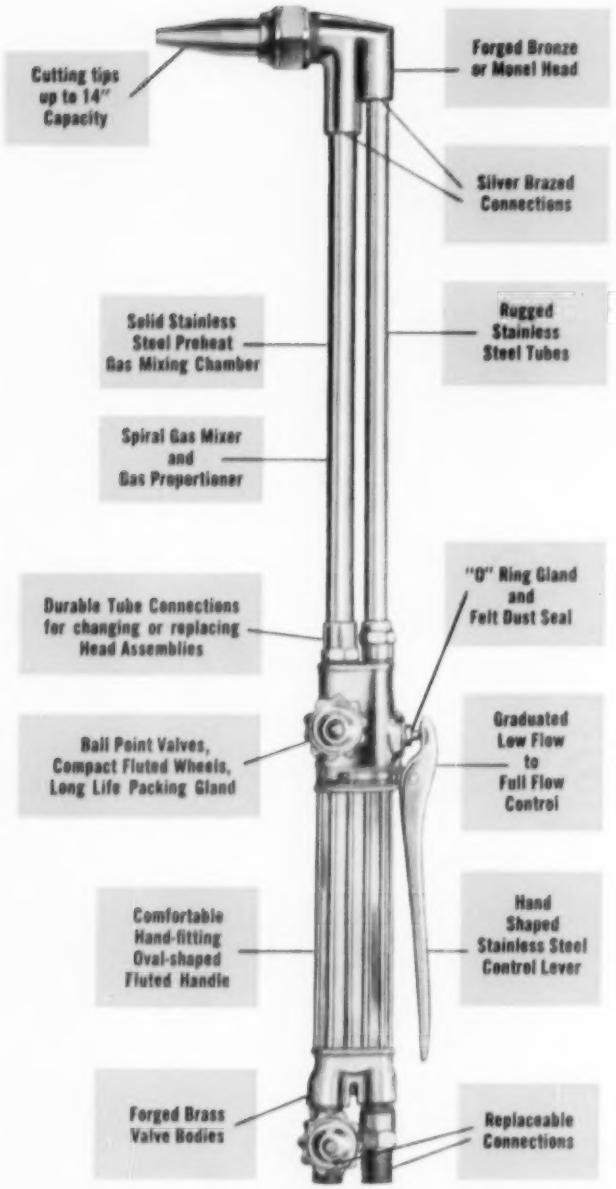
OFFICIAL PUBLICATION OF THE AMERICAN WELDING SOCIETY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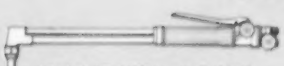
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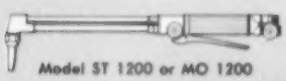
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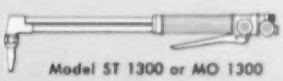
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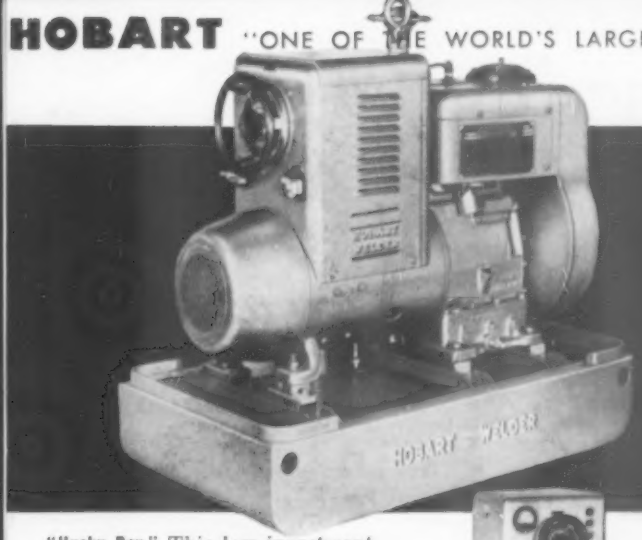

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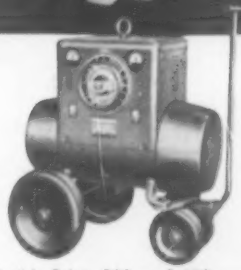

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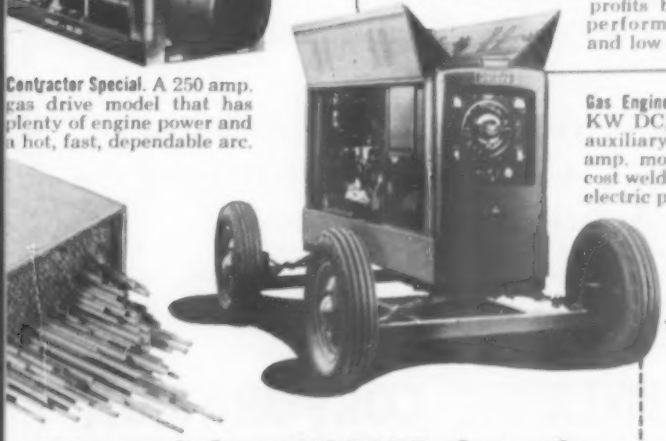

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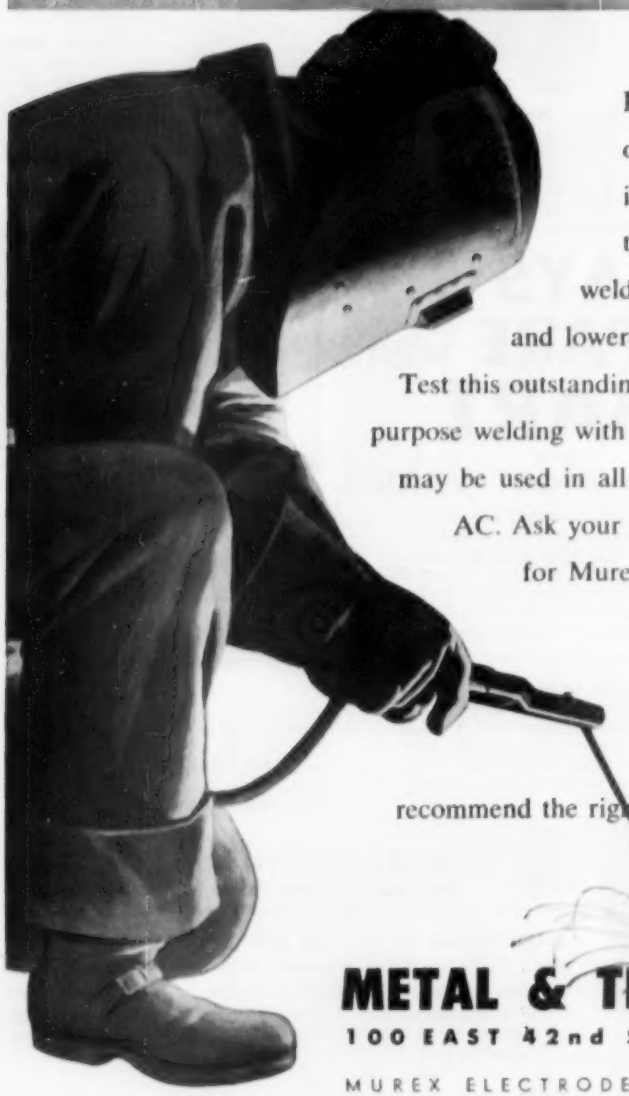

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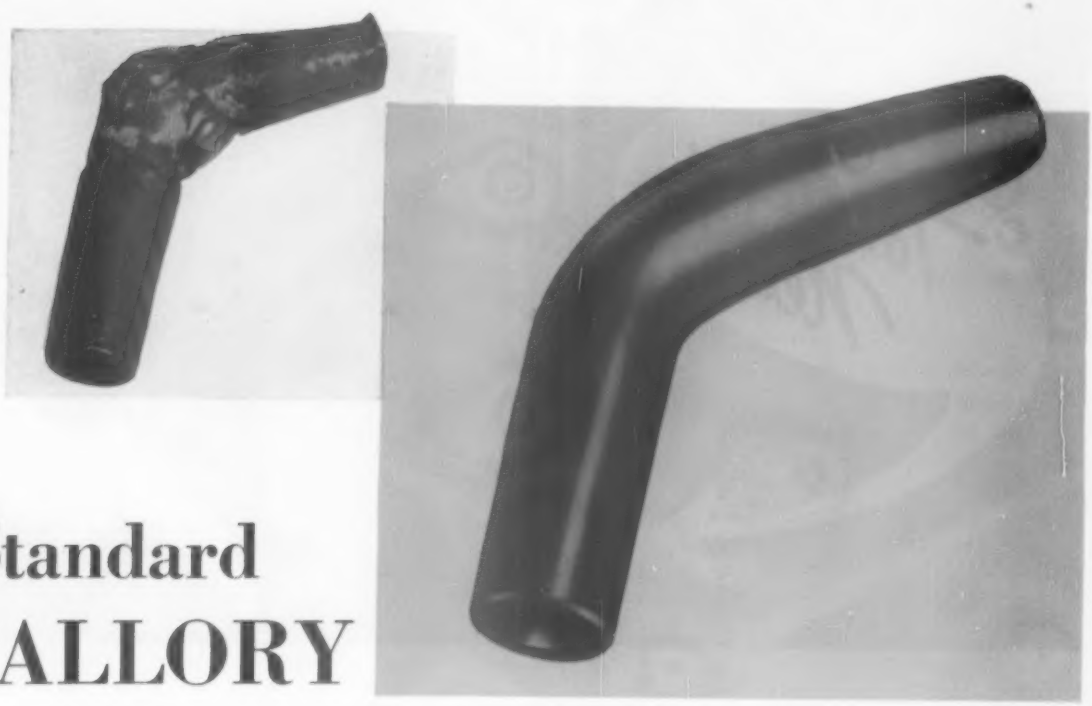

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TO IMPROVE EDUCATION

If public education is to be improved, as it should be, this must be done in our local communities. Better schools in your town and my town and everyone else's town will help improve the total education picture in the United States. Nothing else will.

Schools are managed by local boards of education. These boards function like boards of directors. The day-to-day operation of the schools is usually under the superintendent of schools. His duties are like those of the president of a corporation.

These people need, and want, your help. They cannot abrogate their responsibilities or delegate their authority. They resent interference but will welcome your understanding, advice, cooperation and support.

Here are things that you can do:

Encourage competent people to serve as members of your board of education. These people should be interested in the education of children, not in political patronage, in furthering pet ideas or in aspiring to political jobs.

Encourage the appointment of the best available professional staff and see that salaries are high enough to attract and hold good people.

Help develop a climate in the community that encourages enthusiastic and effective professional work, unhampered by pressure groups, by well-intentioned but overzealous individuals and by special pleaders.

Encourage the development of an up-to-date curriculum, and well-manned, competently administered guidance services.

Support a program for furnishing sound, up-to-date textbooks. Encourage the effective use of motion pictures, slide films and other visual and audio teaching aids. Get behind programs for improving, modernizing or, if necessary, expanding school equipment and buildings.

Remember that school authorities have to furnish education to all the children. The program must be balanced. Special emphasis cannot be given to one phase of education at the expense of others.

All these things cost money. Most of this must be raised in the local community. Some of it may come from state funds. But, we must be prepared to spend more money for education if we are to have better education, or even if we are to hold on to what we now have.

Discuss these things with your school superintendent and with members of your school board. They will have ideas about how you can help. If the opportunity for service on the board of education is offered you, consider it carefully. Here you can make your greatest contribution to the improvement of education, and to the children of your community, of your state and of the nation.

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The appropriate TEMPILSTIK° is selected and, for most applications, the work-piece is marked with it before heat is applied. On subsequent heating the crayon-like mark of the TEMPILSTIK° melts as soon as its temperature rating is reached.

The mark made by a TEMPILSTIK° may gradually change in color as heating progresses. The change in color, or in color intensity, is never to be interpreted as a temperature indication. The TEMPILSTIK° mark melts when its temperature rating is reached and only this change from the dry to the liquid condition is the significant temperature signal.

In some applications this simple method may not suffice because evaporation of the TEMPILSTIK° mark on prolonged heating, or its gradual absorption by the surface at high temperatures, may leave too little residual substance for unambiguous observation. In such cases stroking or touching the work-piece with the TEMPILSTIK° at regular intervals during the heating process is recommended. The TEMPILSTIK° will leave a dry mark at temperatures below its rating and a liquid streak when its temperature rating has been reached or exceeded. If the workpiece is not accessible for applying a TEMPILSTIK° during the heating process, then TEMPILAQ°, or possibly TEMPIL° PELLETS, should be used instead.

TEMPILSTIKS° will usually glide over unheated polished surfaces (like glass, polished stainless steel, etc.) without leaving an appreciable mark. Therefore, in applications that involve smooth or polished surfaces TEMPILSTIKS° should be used by touching or stroking the workpiece periodically during the heating process, as previously described, because a liquid streak will be made on contact as soon as the specified temperature is reached. Where it is necessary to mark a smooth work piece surface prior to heating, TEMPILAQ° should be used.

A hot radiating surface will appear relatively dark under intense illumination from an external source, and this fact can be utilized to improve recognition of the temperature signal against a red-hot background. The use of TEMPIL° PELLETS or TEMPILAQ° instead of TEMPILSTIKS° will further improve visibility under these conditions.

On rapidly moving objects, like magnesium or aluminum sheet during spinning operations, it is impossible to see whether the applied TEMPILSTIK° leaves a dry or melted mark. However, with a little experience operators quickly learn to sense the smooth gliding of a TEMPILSTIK° over a surface which is hot enough to melt it on contact, as contrasted to the frictional drag on a cooler surface. If the top of the TEMPILSTIK° is brought in contact with the moving metal surface for a brief moment at a time, and with light pressure only, the heat contribution of friction is trivial enough to be ignored.

The above described "sensing technique" may also be employed on hot radiating surfaces where the bright background makes it difficult to distinguish whether or not the TEMPILSTIK° mark had melted.

An appropriate series of TEMPILSTIK° marks, applied to the workpiece or surface under investigation before heating begins, will provide a record of the maximum temperature attained during a process or operation. Subsequent examination will show that all TEMPILSTIK° marks up to a certain temperature rating had melted, while those of a higher rating had not. The maximum attained temperature must consequently lie somewhere in the interval between the highest melted and the lowest unmelted TEMPILSTIK° rating.

The temperature distribution and isothermal boundaries of surfaces such as furnace walls, melting ladles, cement kilns, etc., can be established by using an appropriately chosen series of TEMPILSTIKS° to draw a pattern of lines (parallel, concentric, radial, etc.) on the area under investigation. The heat conduction along a surface can be effectively studied by the progressive melting of suitably chosen TEMPILSTIK° lines. Caution must be exercised not to permit the mark made with one TEMPILSTIK° rating to cross or overlap the mark of a dissimilar TEMPILSTIK°, as such a mixing of different TEMPILSTIK° marks would destroy their accuracy.

TEMPIL° products will give good results in induction heating and in ionized air, as well as in the presence of static electricity about electrical equipment, where electrical means of measuring temperatures often function erratically.

Inert-gas metal-arc welding of steel compressor case

The compressor while welding is in progress is securely held by the upper clamp which has moved into position. The clamp and welding head will move to an out-of-the-way position automatically after welding stops.

HIGH SPEED WELDING OF STEEL COMPRESSOR CASES

Paper covers the successful application of inert-gas metal-arc welding to the production of an hermetic line of compressors for room air conditioners and refrigeration

BY C. F. STEPHENSON AND R. A. STONE

Introduction

Considerable effort has been extended during the last few years to develop satisfactory techniques for the manufacture of compressor units for the refrigeration and air conditioning industry.

The York Corp. introduced the hermetically sealed cooling circuit for room air conditioning in 1948. A constant striving to improve the product at lowered cost to the customer led to a partial retooling starting early in 1954 and finishing about ten months ago.

A major consideration was to change the method of "sealing" the compressor case proper. We had been brazing this unit for six years and found the process more costly and not really suited for this job. Early in the planning stage we gave an intensive canvass of all the latest fusion welding techniques and processes—investigating processes already in production and some only in the research stage. Our purpose was not to select a welding method on a "tried and proved" basis,

C. F. Stephenson and R. A. Stone are associated with the York Corp., York, Pa., and Air Reduction Sales Co., Philadelphia, Pa., respectively.

Presented at AWS 1955 National Fall Meeting held in Philadelphia, Pa., October 17–21.

but to project our thinking a year or two ahead and select a process which appeared to be of the future.

Consideration was given to resistance welding, brazing, open-arc welding, submerged-arc welding and inert-gas-shielded arc welding. Of the five processes the one which seemed to have the most promise was inert-gas-shielded metal-arc welding using a consumable electrode.

Selection of the Welding Process

Table 1 illustrates the various features of the processes under consideration. Starting with resistance welding, the very high cost of a machine to seam weld $^1/_8$ in. material to $^1/_8$-in. material was the major point for consideration. The size of the welding equipment would be very large; however, the initial cost and size is overshadowed by the expense involved in changing the design of the compressor casing to be adaptable to this process and the added cost of maintaining critical tolerances required of this type joint. Other objections are that the compressor would be larger, taking more room in the unit and if the compressor need be opened after welding, it would mean cutting away all of the flange in order to get beyond the weld. This would be wasteful as the casing parts would have to be scrapped.

The open arc (bare wire welding) has definite limitations as far as weld quality is concerned. The inherent brittleness and attendant susceptibility to corrosion of the weld deposit are well known. Some thought was given to a lightly coated electrode which would produce better quality weld metal but here, we run into a cleaning problem which is difficult and costly.

Submerged arc also has the problem of slag removal. It is recognized that under proper conditions this could be a minor consideration but we found that this removal operation could be a considerable factor in setting wage rates. The weld also has a tendency to stay hot for quite some time under the adhering slag blanket and it is quite difficult to remove the slag until the metal is somewhat below the red heat. This makes immediate handling almost impossible and promotes heat transfer to interior surfaces and the resulting scale formation. The use of granular flux was also considered objectionable—not only because of the extra machinery involved, but also because of the "messy" shop conditions and the possibility of the particles getting into the compressor proper and damaging the machinery unless the casing was redesigned. Brazing has been used at York since 1948. Table 2 illustrates the very high materials cost in comparison with the inert-gas metal-arc process. A reduction of costs in this age of keen competition is quite significant.

Table 1—A Comparison of the Desirable Features of the Processes Under Consideration for Welding Steel Compressor Cases

Process	*Resistance*	*Brazing*	*Open arc*	*Submerged arc*	*Inert-gas Metal arc*
Tooling—cost	High	Medium	Low	Low	Low
Materials—cost	Low	High	Low	Low	Low
Preparation—labor cost	Low	High	Low	Low	Low
Welding—labor cost	Low	Medium	Low	Low	Low
Finishing—labor cost	Low	Low	Low	Medium	Low
Quality of weld	High	Medium	Poor	High	High
Heat-affected zone	Small	Large	Large	Medium	Small
Leak probability	?	Low	High	Low	Low
Repair difficulty	Great	Medium	Little	Little	Little
Objectionables	None	Some	None	Some	None
Positive statements	8	2–4	8	7–8	10

The major cost reduction has been in material; however, welding has eliminated several labor operations, such as fluxing by hand and placing eleven small pieces of silver alloy wire on the joint to be brazed. Welding also produces a better product, not only stronger, but the heat-affected zone being much narrower gave a cleaner interior and permitted the use of a new type of electrical terminal connection using a glass and metal bond. These small terminals are resistance welded into the housing before welding the girth seam.

The selection of inert-gas metal-arc welding over submerged arc still depended on proved quality and costs. A projection of costs indicated that submerged arc would be cheaper than a high priced inert gas. However, this small difference (about $0.01 per compressor case) was outweighed by the total absence of granular flux. Also considered was the possibility that a cheaper shielding medium would be found in the near future. Carbon dioxide may be the answer; however, little data from production applications seem to be available at this time.

Planning for Production

A grade of electrode wire known as "A675" was

Table 2—Illustrating the Savings of Shielded Inert-Gas Metal-Arc Welding Over Silver Brazing for This Application

Induction Brazing		*Shielded Arc Process*	
Silver solder	$0.317	Wire	$0.024
Flux	.046	Argon and oxygen	.026
Labor and Overhead	.195	Labor and overhead	.065
		License fee	.001
Total	$0.558	Total	$0.116
Brazing cost	$0.558		
Welding cost	.116		
Savings per compressor	$0.442		

selected for its low cost and because it had been designed specifically for use with the inert-gas-shielded metal-arc welding process. The quality of deposited weld metal had been given intensive study by the manufacturer. However, we had several welded compressors thoroughly checked by our own and an impartial commercial laboratory. Our findings merely corroborate the published data on this material, i.e., that the ultimate tensile strength was over 70,000 psi and that the elongation was in the neighborhood of 22% in 2 in.

The chemistry of the electrode wire and the compressor cases is given in Table 3. The high manganese and silicon of A675 is a requirement for "killing" the weld puddle and promoting high strength. Low sulfur and phosphorus promote high impact values and retard cracking.

Table 3—Chemistry of Three Steel Cases Welded with A675 Wire and the Average Leak Percentage with Each

	Welding wire A675	*Stamping supplier "A"*	*Stamping supplier "B"*	*Stamping supplier "C"*	*Stamping supplier "D"*
Average leaks	...	10%	2%	2%	2%
Size compressor	...	Triple	Double	Double	Double
Steel type	...	Rimmed	Killed	Killed	Rimmed
Average Analysis					
Carbon	0.10	0.06	0.07	0.08	0.08
Manganese	1.00	0.27	0.35	0.35	0.38
Silicon	0.40	...	...	...	...
Aluminum	...	...	Trace	Trace	...
Phosphorus	0.02	0.01	0.01	0.01	0.01
Sulfur	0.02	0.027	0.024	0.023	0.028

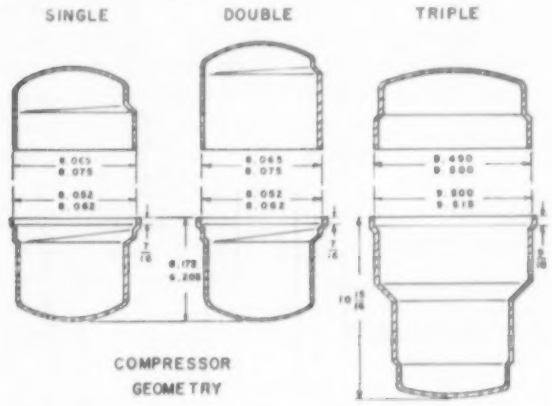


Fig. 1 Geometry of various compressor cases illustrating the tolerances necessary for quality welding

An interesting comparison of the chemistry of the base metal from four suppliers of stampings shows that little difference can be detected between rimmed and killed material as long as the manganese is in the neighborhood of 0.35%. Leakers will climb to about 10% when the manganese gets as low as 0.27 to 0.25%.

In addition to the chemistry and strength, other details were required to promote the best welding conditions. At the outset of our experimental program it was thought that electrode alignment would be so critical that our supplier of cases would not be able to

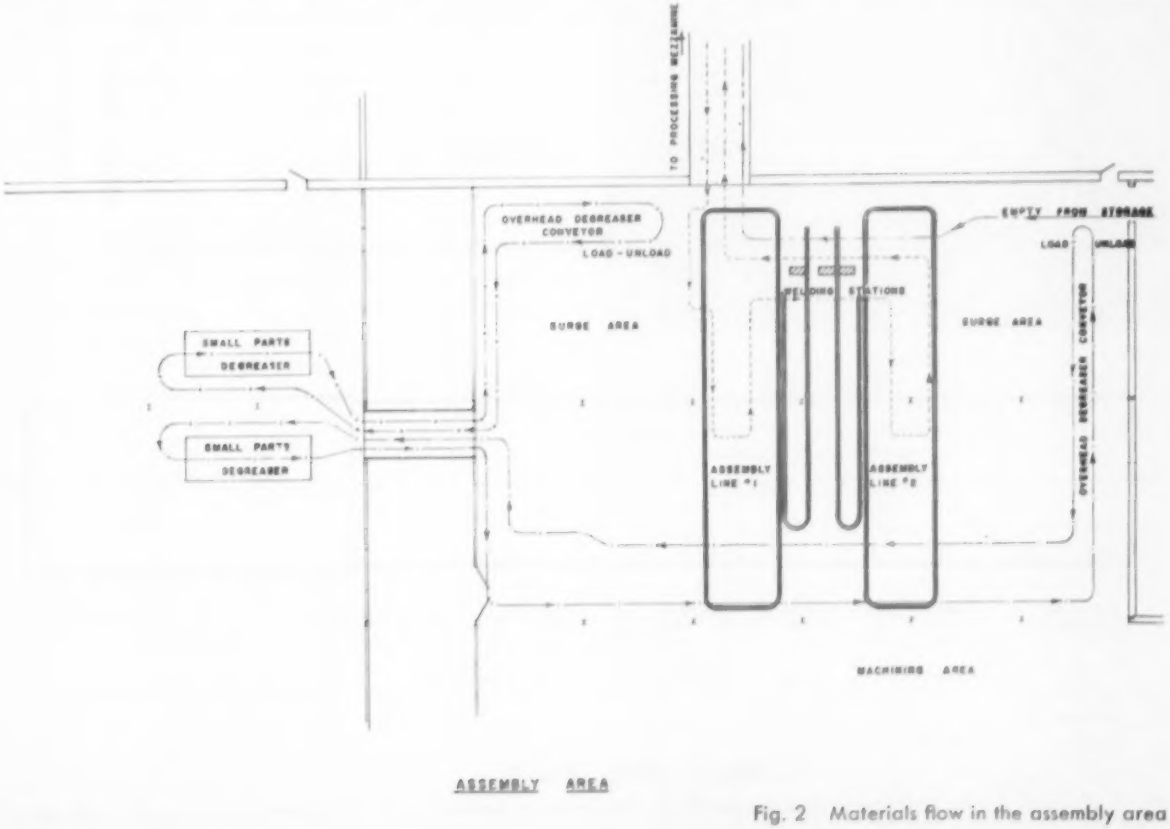


Fig. 2 Materials flow in the assembly area

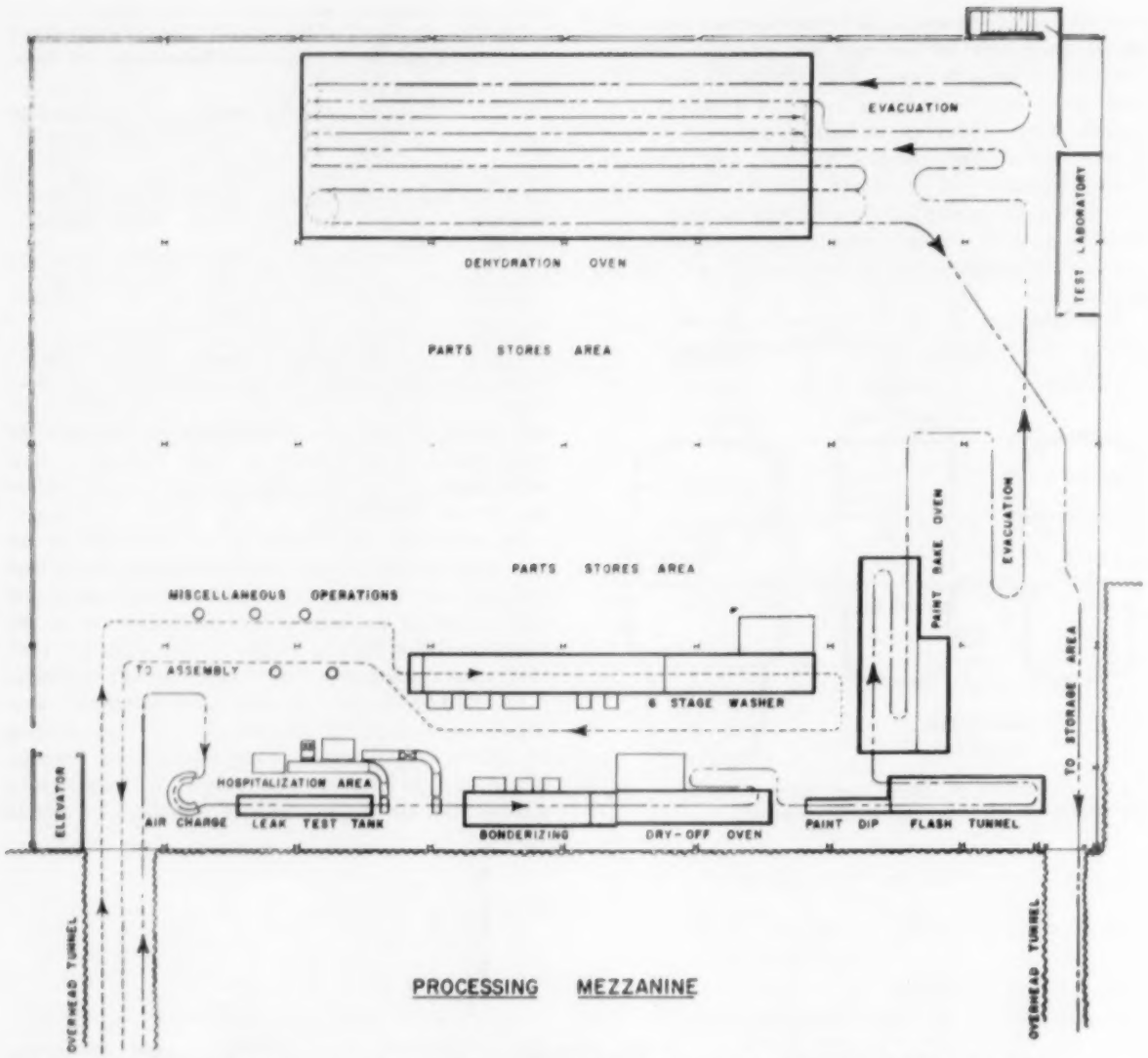


Fig. 3 Materials flow in the cleaning area. This illustration also shows the testing, painting and dehydration area

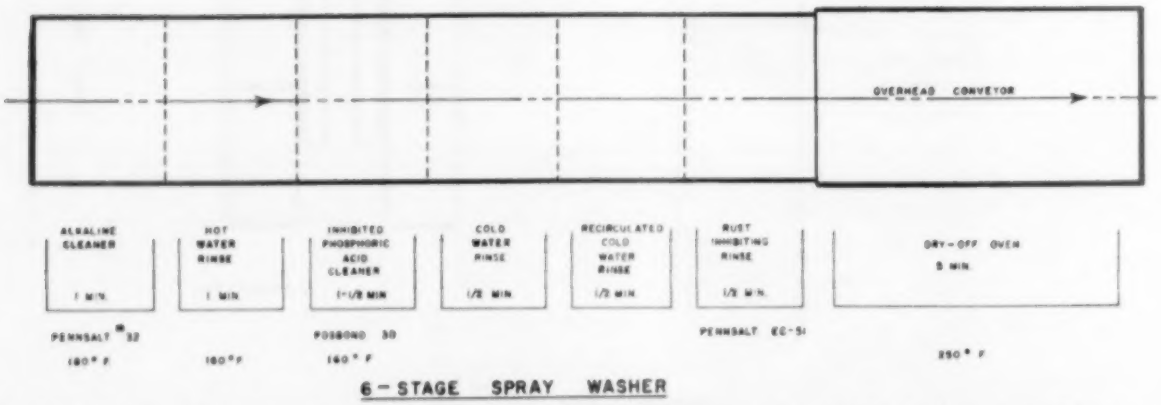


Fig. 4 Cleaning of the stamping is closely controlled. The cleaning sequence prior to welding is shown in this illustration

hold the required tolerance. Before limits were determined, a full scale investigation was made on how the electrode could be indexed from the weld joint for each size and type of case.

While this is not too difficult, a complicated and more expensive welding fixture is necessary with added cost and maintenance. After production work it was found that a $^1/_{16}$ in. electrode alignment would still keep the joint well within the "good weld tolerance". Figure 1 illustrates the specifications passed along to the supplier of cases. They consistently maintain these dimensions and the operator at the welding station very seldom has to adjust the electrode alignment.

The system of sizes has been designed so that the capacity of the compressor is increased by combinations of housings and covers. The present production line can manufacture three sizes of compressors. They are: single cylinder $^1/_3$ and $^1/_2$ hp; double cylinder $^3/_4$ and 1 hp; triple cylinder $1^1/_2$ hp.

Production Facilities

The conveyor system: all the machined parts are conveyorized to a surge area adjacent to the degreaser. As shown in Fig. 2, machined parts are degreased and fed to the two assembly lines by overhead conveyors. The cover and housing are fed from the mezzanine, where it is carried to the assembly lines by the second overhead conveyor. The compressor is completely assembled by passing over a floor conveyor to the last operation of assembly, which is welding. Here, after welding, it is hung on the third overhead conveyor and carried to the mezzanine for processing (see Fig. 3). After testing, bonderizing, painting and evacuation, the compressor is carried to another building where it is removed from the conveyor and stored, waiting assembly into a unit. The conveyor then returns to the welders with empty hooks.

Any foreign material which may be trapped within the compressor reduces the efficiency and shortens the life of the unit. Much attention is given the interior, so a complete cleaning and conditioning system has been installed to handle 180 assemblies per hour (Fig. 4). The housings and covers are hung on an overhead conveyor (Fig. 5) which moves at a constant speed rate through a series of spray baths. The cleaning sequence is as follows: alkaline cleaner, hot water rinse; inhibited phosphoric acid cleaner, cold water rinse; recirculated cold water rinse, rust inhibiting rinse, and a drying period.

There are many dimensional checking and inspection stations during the assembly of the unit. Immediately before the cover is put on the assembly, a capacity and power consumption test is performed. Temporary electrical and pumping connections are made and the unit is operated for 30 sec. It is required to pump dry air at 70° F against a 150-lb head. After the cover is placed on the unit, it is tested for noise level. The compressor is run for 30 sec in a soundproof booth. This is the last inspection prior to welding.

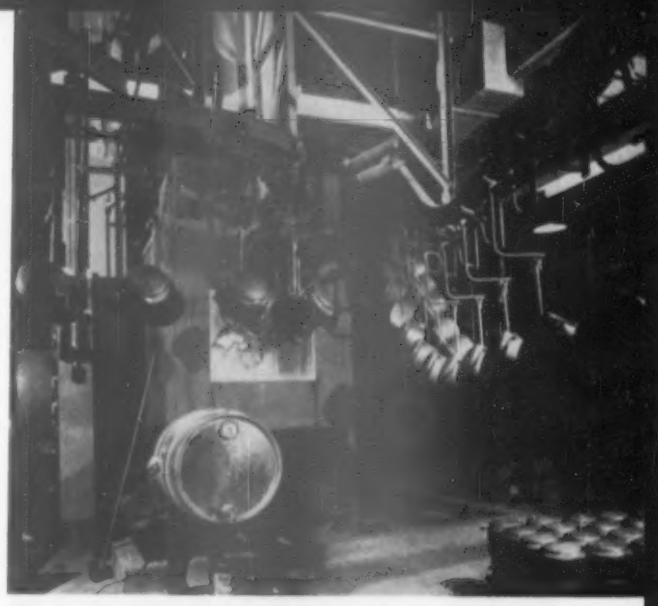


Fig. 5 Compressor housing and cover entering an automatic spray washer. The line at reader's right shows the cleaned units on their way to the assembly area

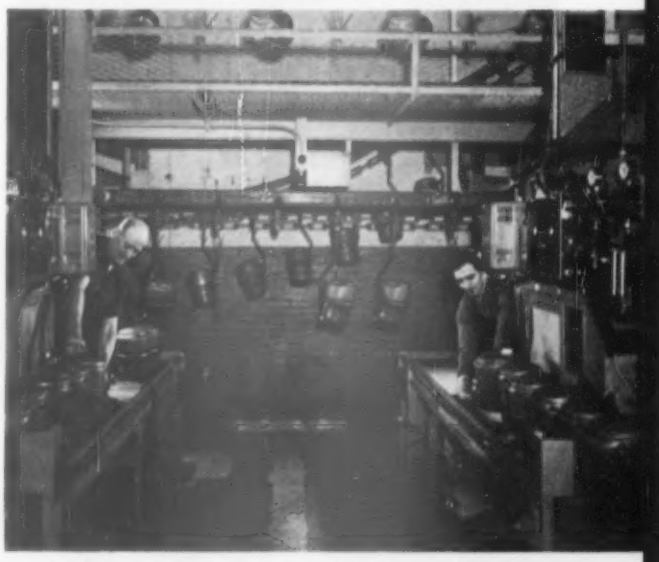


Fig. 6 The compressor is delivered to the welding stations on a gravity conveyor. The operator pushes the units through the small curtained opening into the booth. The welding controls have been mounted so that they can be readily checked by the supervisor

The small cases are set on cast aluminum disks and easily pushed along a roller conveyor to the welding station. They are moved into the welding booth on a small transfer table through a curtained opening (Fig. 6). The compressor is lifted and placed into a special head stock which indexes off the small mounting boss, located on the side of the housing. After the case is set firmly into the head stock (Fig. 7), the operator merely pushes one button—an arm swings into position and firmly clamps the two halves together and the welding head moves into position and starts the welding cycle

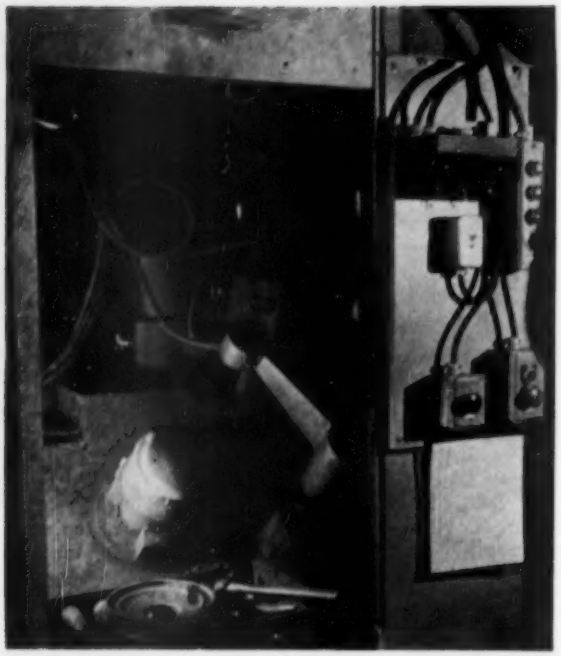


Fig. 7 The compressor is lifted from the aluminum conveying disk and placed into the head stock. Positive alignment is obtained by locating off the small mounting boss. The welding conditions for the type compressor being welded is ready for quick reference by the operator just beneath the starting button and emergency stop switch

(see lead photo). After the cycle is complete, the welding head and clamping arm return to an out-of-the-way position. The operator, by means of a foot switch, operates an air cylinder which pushes the completed compressor case from the head stock. He then hangs it on the overhead conveyor system (Fig. 8). The completed weld is smooth—free from any slag or scale (Fig. 9).

Welding Conditions

The welding conditions which have been determined over a period of nearly one year are illustrated in Fig. 10. It should be pointed out that they are under constant revision as data accumulates over production periods of two or three weeks. Our investigation has taken us through a current range of 350 to 550 amp adjusting the electrode approach angle accordingly for each setting being studied. It may be stated that quite a few variables have a direct, interrelated effect on the final weld. Some of these are: shielding gas flows and oxygen percentages, current, angle of electrode approach, wire diameter, type of steel used in compressor case and the cleaning procedure. It is not the purpose of this paper to dwell exhaustively on how we arrived at these data except to mention that our entire program is aimed at producing the best possible product at the lowest cost. We have concluded that all joining processes involved in our hermetically sealed units must produce the least possible number of leaks. We have welded at surface speeds of 80 ipm with good appearance;

Fig. 8 The back of the welding booth showing the conveyor which will take the units to the test station. An air-operated lift has been installed at the end of the line to facilitate loading of the heavier compressors

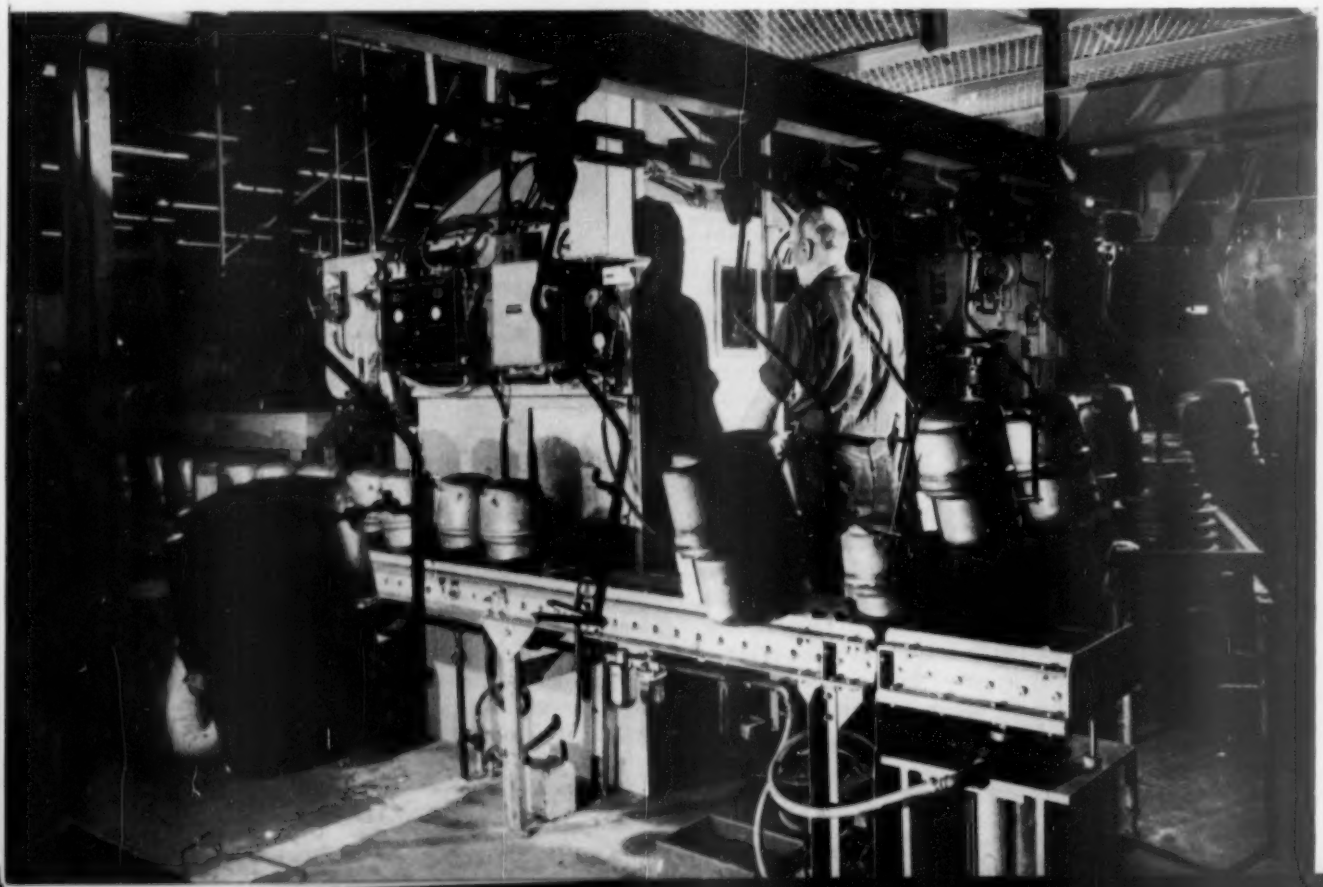
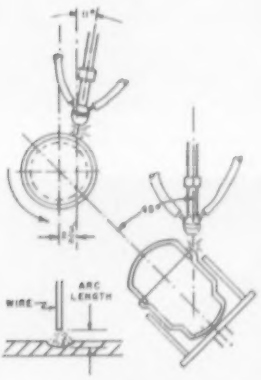


Fig. 9 The weld is smooth, free from defects and will accept paint without special cleaning

however, the number of leaks rises to a point where the quality of the product may be seriously lessened. This is based on the fact that our testing procedure may miss leakers as the probability percentages increase.

Some work has been done with specially coated wire using straight polarity and with wires containing higher percentages of alloying elements than A675. Each had an optimum working range; however, each was discarded for one reason or another. Some of these trials lasted for one or two weeks in order to determine weld quality and costs under the most favorable conditions.

One very interesting phenomenon not immediately



WELDING INFORMATION	
WIRE DIAMETER	1/16 IN.
ARGON FLOW	42 CFH
OXYGEN FLOW	1 CFH
ARC VOLTAGE	27
AMPERES	375
SURFACE SPEED	50 IPM

Fig. 10 Welding conditions that have been established over a period of one year

Fig. 11 First test station where the compressors are coupled to a pumping system that pulsates between 100 and 350 psi internal pressure. The operator is shown attaching the pump to the process fitting on the unit

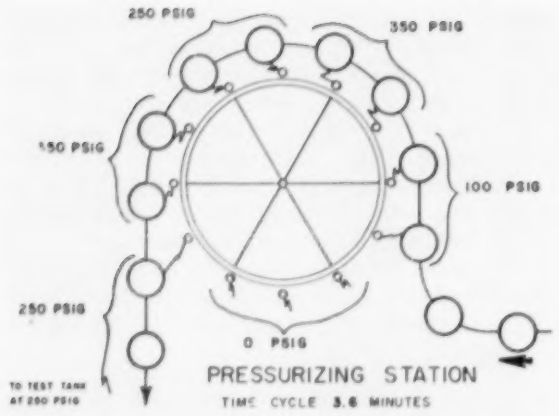


Fig. 12 The internal pressure is pulsated five times while going through the pressurizing station. Pressure is maintained by the process fitting at 250 psig when leaving the station

Fig. 13 Submerging tank in which each compressor is kept for 3 minutes while pressurized at 250 psi. Note that the third case from the bottom of the picture is leaking from a brazed joint. Weld leakers usually show as a very fine stream of air bubbles instead of such turbulence pictured here

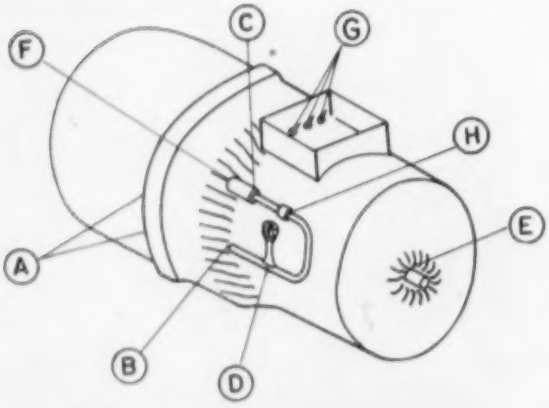


Fig. 14 The leak diagram illustrates the possible points of failure and lists them in descending frequency

clear is the fact that a $^{3}/_{32}$ in. diameter wire, under the best operating conditions, will produce about 100% more leakers than a $^{1}/_{16}$ in. diameter wire. It has been suggested that the higher current density on the smaller electrode gives less turbulence, more arc stiffness, possibly less penetration and less chance for porosity to form. The weld bead is smaller with $^{1}/_{16}$ in. diameter wire and of better shape. This also means that the temperature gradients are steeper and that there is less disturbance and less melting of base material.

After welding, the compressors are conveyed to the testing station. Each compressor has been equipped with a small process fitting to hold internal pressure. The operator of the station fastens a quick acting connecting link to a pumping station (Fig. 11) and as the case travels in a semicircular path, an internal pressure of dry air is pulsated, as shown in Fig. 12.

Pressure Testing

Each compressor is then submerged in a leak test tank for approximately 3 min while pressurized with 250 psi of dry air (Fig. 13). The entire tank is lighted through portholes. The interior is painted white and is charged with city water and rust inhibitors. The charge is changed after each 8-hr operation.

All leaks are identified for type and position by a lettering system. The test tank is under constant observation by an operator who marks the leaking compressor and removes it from the line conveyor to the repair conveyor. Figure 14 gives a good picture of the numbering code and our present relative leak frequency.

The process connections and terminals are masked and the surface is prepared for dip painting by alkaline cleaning and bonderizing. The paint is fixed in a baking oven which is vented to the roof. At the outset of our testing program we are concerned with a light film of "dust" which was deposited on the steel surface adjacent to the weld area. The dust was proved to be extremely fine particles of iron and iron oxide which are projected to the work, falling outside the protective covering of the inert gas. Several studies were made to determine its effect on paint adherence. It was reported that after testing under extremely humid conditions the paint held to the "dusty" areas better than the rest of the compressor surface.

Dehydration

Removal of any moisture from the motor windings and compressor parts is accomplished by the application of heat and extremely low pressure. A completely automatic dehydration oven was designed specially for this effect. The cases are moved into the oven on an overhead conveyor. A small electric motor powered pump follows at the same speed providing a means of evacuation. The entire process requires about $6^{1}/_{2}$ hr and is accomplished in the following stages:

The first stage exhausts the compressor for about 10 min while at 80° F.

The second stage heats the entire compressor for 2 hr at 290° F. The compressor emerges at 250° F.

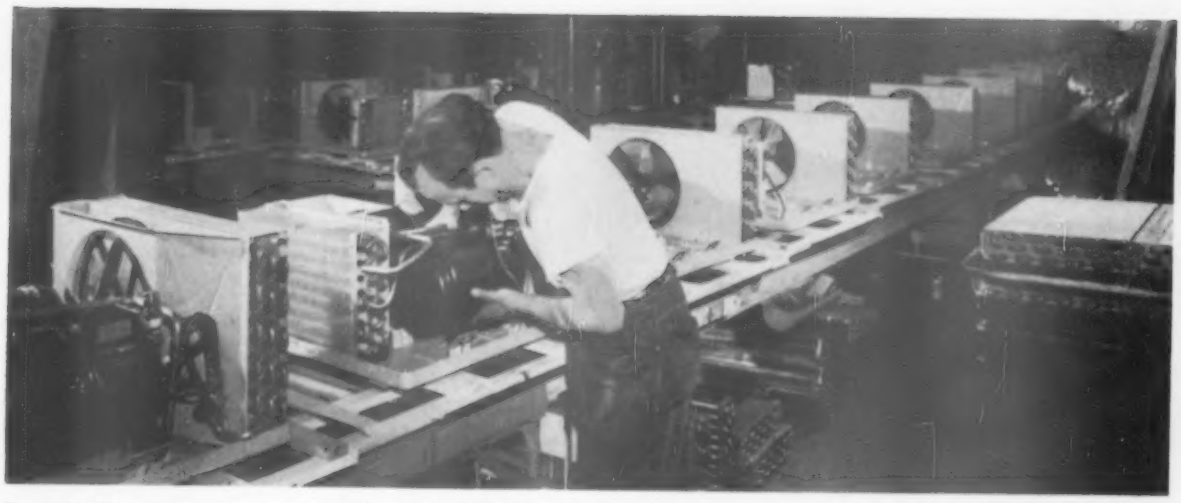


Fig. 15 The compressors are mounted on rubber isolators and are given a pressure test using a 15% freon-air mixture

The third stage exhausts the compressor for 20 min while at 250° F.

The fourth stage is another heat cycle of 3 hr at 290° F.

The fifth stage consists of a simultaneous heat and exhaust cycle at 290° F to a final total pressure of about 75 microns. This pressure is a good indication of moisture content and is used for quality control.

The compressor while still under vacuum is then filled to about 5 psi of minus 40° F dewpoint nitrogen. A data and identification plate is attached to the compressor at this point, and the compressor is then sent to storage.

Final Assembly

The unit may be in storage for quite a few months before being assembled in a room air conditioner chassis and the refrigerant circuit made up by silver brazing (Fig. 15). After the refrigerant circuit is assembled it is checked for leaks by pressurizing to approximately 315 psig and by checking with the leak detector. After the interior has been filled with a freon-air mixture, a G-E type probing unit is passed over the unit concentrating on the joints. An audio alarm will signal the operator when small concentration of freon is detected.

The second inspection is done at the helium tower. Here, the refrigerant circuit is exhausted to a pressure less than 100 microns and sealed. The unit is then placed on an elevator and raised inside the tower into the atomosphere of about 10% helium – 90% air mixture for 13 min. After the circuit has been subjected to this atmosphere, the inside volume is sampled and analyzed on a mass spectrometer for the presence of helium. If helium is present, there is a leak in the circuit and it is recycled to the repair station. The mass spectrometer has a minimum sensitivity for detecting any leak greater than 1 oz in 15 yr.

Final inspection of a unit is accomplished in an enclosed room using freon and air with a G-E leak detector. Here, again, we use a minimum sensitivity of 1 oz in 15 yr. Each weld must pass a minimum of 5 checks. However, the real quality indication is that we have been able to find all our leaks in the water test tank in the hermetic shop (the first test). Our performance on the seam in the subsequent unit tests has been such that we now feel safe in eliminating these tests on the compressor seam. The total station time on unit tests is now being spent on checking of joints.

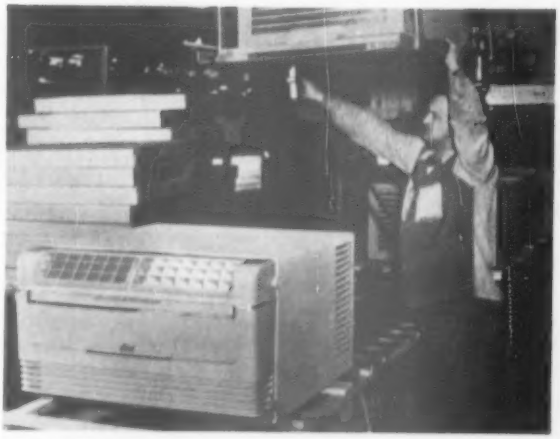


Fig. 16 A completed room air conditioner

The work covered by this paper involves the production of our "small" hermetic line of compressors. Several months ago the success of this process became apparent and we immediately made plans to expand its application to our complete line of hermetic compressors up to and including $7^1/_2$ hp. Our plans were approved by management and we are now installing this operation in our "large" hermetic shop. This is the best assurance we can give of our confidence in the continued performance and improvement of this technique. The completely assembled room air conditioner is shown in Fig. 16.

Fig. 1 Fixed platform and floating tender

OFFSHORE DRILLING BARGES

The development of offshore oil wells has resulted in the construction of a number of unusual types of structures for drilling purposes

BY ROBERT H. MACY

Background

The first successful oil well in the Gulf of Mexico was discovered and produced by the Pure Oil Co. in 1938. This ordinarily would have led to the rapid development of oil production in the Gulf, but World War II brought any expansion practically to a halt.

After the war in 1947, Kerr-McGee made an important discovery which immediately became a major producing well and was actually the first real offshore well, it being the first one that was located entirely out of sight of land. During the next few years perhaps two dozen other successful wells were produced in the Gulf of Mexico, but eventually the program bogged down during the so-called Tidelands litigation and the subsequent adverse decision of the Supreme Court.

Recently the Supreme Court made a partial clarification in defining the geographical boundaries of the states, which although not completely solving the problem has permitted offshore drilling to proceed at a rapid rate.

For the time being it is likely that drilling in deep water will be confined to what is known as the Continental Shelf of the Gulf of Mexico, which is the area between the coastline and the 600-ft depth line. Actually the present state of development of equipment for drilling so far has made it possible to drill in not over 100 ft of water.

The Continental Shelf area along the Louisiana and Texas coasts amounts to some 25,000,000 acres and the width of the Shelf varies from a few miles to about 150 miles. Just beyond the Continental Shelf the water depth increases very abruptly. The fact that so much oil has been produced on shore along the Gulf of Mexico made it obvious that the same oil must also exist out in the water and this has been amply demonstrated by the success so far in drilling wells offshore. Actually the exploration for oil by seismographic methods is much simpler conducted from boats in the water than it is from land equipment, especially in marshy or heavily wooded areas. Due to this the percentage of successful wells out of the total number drilled has been very high offshore, running around 40%.

Even so, only a relatively small area of the Continental Shelf has been explored and geologists predict that there may be as many as 300 oil bearing structures in this area. In order to drill these, there will probably be from 50 to 100 drilling rigs working in a very short time. Since it takes about seven wells to properly test each structure, this means a huge sum of money will shortly be spent in exploratory drilling alone in the Gulf of

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Mexico. Following this exploratory drilling, it has been forecast that at least 7500 wells will be drilled on the Continental Shelf. Only a small fraction of the equipment required for such a program is in existence today.

The major development in offshore drilling has been in the Gulf of Mexico, although there are a number of fairly deep water wells in Lake Maracaibo as well as in the Persian Gulf, and in spite of the extremely rapid rate of drop of the bottom of the sea off the California coast, equipment is now being developed that will permit working in the great depths of water prevailing in that area.

Types of Drilling Equipment

This tremendous development has resulted in the construction of a number of unusual types of structures for drilling purposes. The first and still one of the standard methods of drilling is from a fixed platform, supported on piles driven through a template made of braced steel tubing. One of these structures is now operating in a depth of water of 97 ft. Some of these platforms are supported by piles no less than 450 ft long, due to the very poor soil condition prevailing off the Louisiana coast, which has an extremely small load bearing value. The disadvantage of this type of platform is its lack of portability and while 85% of the structure can be moved, it is a costly operation and the remainder of it must be left in place abandoned. Cost is 5 to 7 times as much as on land.

Fig. 2 Submersible drilling barge—sliding pontoon type

The largest of these fixed platforms are complete self-contained units, containing all of the drilling machinery, piping, mud and other supplies and even the living accommodations for the personnel. These platforms cost from $1,000,000 to $2,000,000 each.

In order to reduce the unsalvageable loss associated with the self-contained fixed platform, a number of companies are using smaller platforms of the same type but large enough to contain only the derrick and the drilling machinery, with the supplies and personnel on board a floating tender moored adjacent to the platform, as is illustrated by Fig. 1. Originally these tenders were converted Navy vessels, but in recent years some new tenders have been built, some self-propelled and others not. The tender is, of course, completely portable and a major portion of the platform can also be moved in the event of a dry hole.

Mobile drilling units are entirely portable and about a dozen basic types of these are under construction or in use at the present time. The original was Kerr-McGee's Rig 40, which was similar to a conventional shallow water drilling barge, which simply submerged on the bottom until the main deck of the hull was almost awash, the difference being that the main drilling platform was raised above the deck of the barge on columns to keep it a safe distance above the surface of the sea. This presented a problem in stability, because if the hull were submerged below the water line, there would be no water plane area left to provide stability without the addition of some pontoons alongside. These pontoons can be so arranged that they slide to the bottom once the barge is in place, or they may be hinged, and once the barge has reached bottom allowed to lay flat on the ocean bottom and provide some additional means of bottom support as well as to protect the main hull from scouring of the soil due to underwater currents or storm action. This type of barge is represented by Kerr-McGee's Rig 40 and more recently of Rig 44 and is considered to be economical up to water depths of possibly 40 to 45 ft. Figure 2 shows one of the most recent rigs of this type.

New Types of Rigs

An example of the hinged pontoon type of drilling barge is the "Mr. Charlie," owned by the Ocean Drilling and Exploration Co. This is shown in Fig. 3, and has pontoons at one end only. In operation this barge is put down by the "one end down" method with the pontoons remaining at the surface until the opposite end has reached bottom. After this point is reached, the pontoons are flooded and that end lowered. Once the hull is on the bottom, the pontoons are allowed to hinge out and lay flat on the bottom to prevent their offering resistance to waves.

On some more recent designs, hydraulic rams have been provided to force these pontoons against the bottom and thereby contribute to the support of the structure.

Beyond a depth of 40 to 45 ft, it becomes advisable to make a modification to avoid making the drilling

platform excessively high above the barge hull, with resultant problems in stability. This scheme consists of a jacking mechanism, which permits the main drilling platform to be carried reasonably close to the hull during the period of submergence, and once the main hull is on the bottom, the drilling platform can be jacked up some 30 ft or more to provide a safe clearance between the platform to protect it from wave action during storms. The economical limit of this type of barge is somewhere around 60 to 65 ft.

For operating in water depths of over 65 ft, it is necessary to use another type of barge. One of the largest units so far built and which can operate in 100 ft of water is the Offshore Co. Barge No. 4, shown in Fig. 4. This is a self-elevating hull type and has fourteen caissons 200 ft long and 6 ft in diameter. At the bottom of each caisson is a cylindrical tank, 18 ft high and 16 ft in diameter, which are used to limit the amount of penetration into the bottom. In operating this barge the caissons are lowered to the ocean floor and a group of jacks on each caisson then forces the caissons into the bottom until the resistance becomes sufficient to lift the hull out of the water to the desired height. The hull of the barge, which is also the drilling platform, is 200 ft long and 117 ft wide, although the helicopter platform on one end makes the over-all length 271 ft.

For many years oil well drilling has been conducted by shallow water barges, operating in marshes and inland bayous in depths of water of 6 to 12 ft. An interesting conversion is being performed on one of these to make it suitable for offshore service. This is Kerr-McGee Oil Industries, Inc., Rig No. 45, which is being rebuilt at the plant of the Ingalls Shipbuilding Corp. in Pascagoula, Miss., by providing a completely new hull, columns, bracing, pontoons and drilling platform. The machinery on some of the mud tanks, as well as the derrick, are being taken off the old one and installed on the new. Figure 5 shows how this rig was originally built and how it will appear after conversion to an offshore drilling barge. This method offers great possibilities to the owners of shallow water barges who may desire to have them converted for drilling in deep water.

R. G. LeTourneau, Inc., is building one of the most unusual drilling platforms which has a triangular plan and three truss type columns. These are operated in the same manner as the air and hydraulic jack device, except that electric motors and reduction gears are used which drive racks and pinions on each vertical member. There are 63 motors for this purpose. This unit is not yet in service.

Figure 6 shows one of the latest types of submersible drilling barges which can operate in water up to 100 ft and could no doubt be designed to work in even deeper water, if desired. It consists of an upper and lower hull, one of which nests into the other, and the barge is towed with the hulls in the nested position. On reaching location the lower hull, to which the caissions are attached, is first lowered to the bottom, thus providing positive stability and means of support. Then the main hull is elevated, climbing up on the caissons until the desired clearance above the water line is reached.

Drilling barges require power for raising, and up until recently, it has been necessary to provide substantial electric generating capacity to operate pumps for this purpose. The development of the Diesel electric rig, which is likely to replace the old mechanical drive, provides a source of power for this purpose, which will be taken advantage of on most future designs. The availability of generating capacity for operating the drilling rig which does not operate during raising and lowering, can be utilized to operate ballast pumps, hy-

Fig. 3 Submersible drilling barge—hinged pontoon type

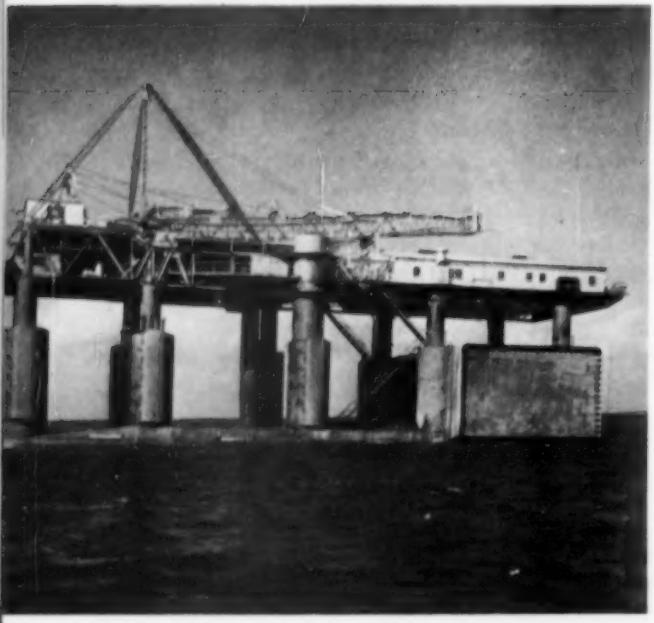
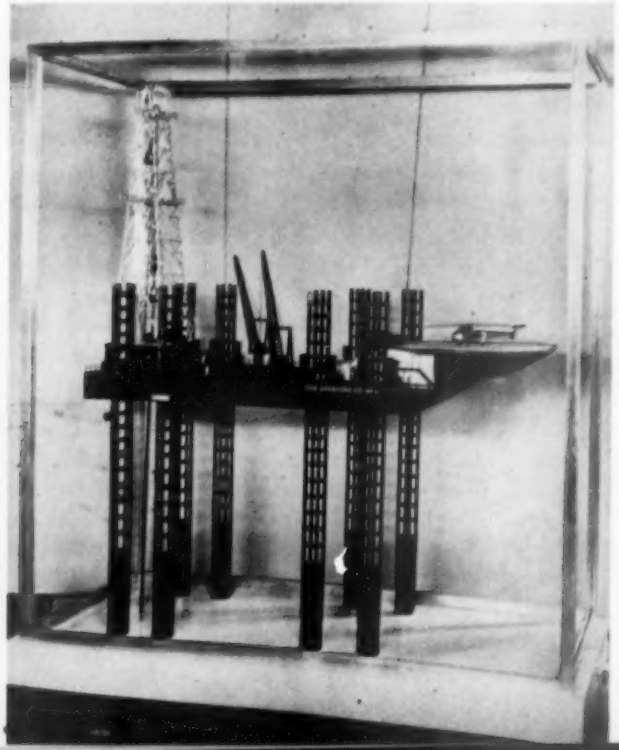


Fig. 4 Elevating deck type drilling barge



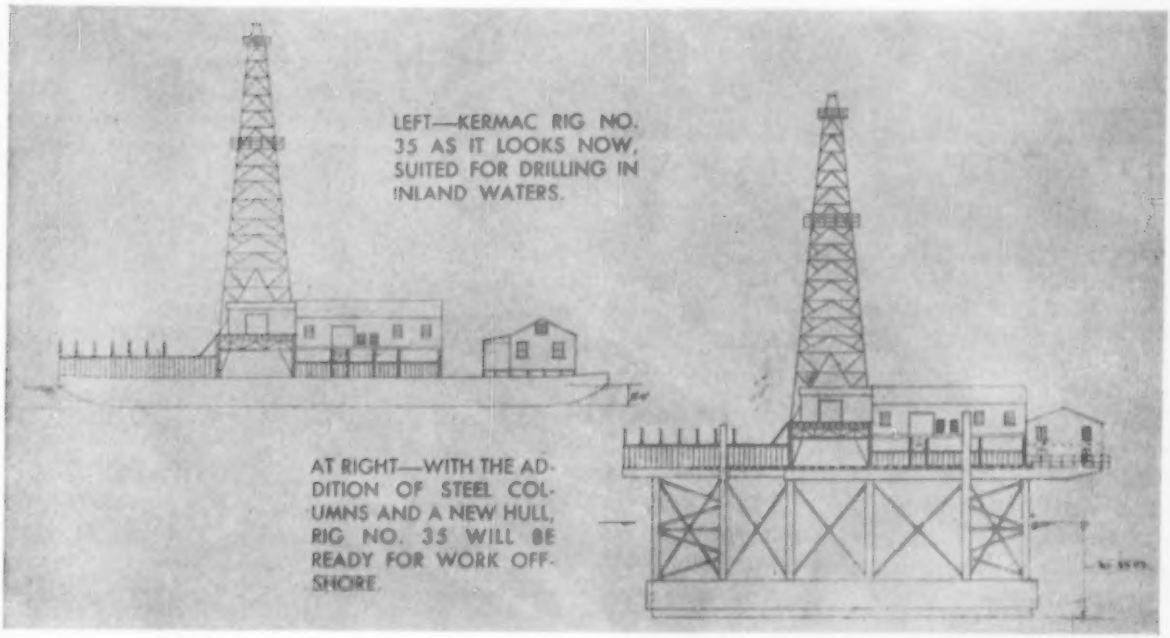

LEFT—KERMAC RIG NO. 35 AS IT LOOKS NOW, SUITED FOR DRILLING IN INLAND WATERS.
AT RIGHT—WITH THE ADDITION OF STEEL COLUMNS AND A NEW HULL, RIG NO. 35 WILL BE READY FOR WORK OFFSHORE.

Fig. 5 Conversion of shallow water drilling barge to offshore submersible drilling barge

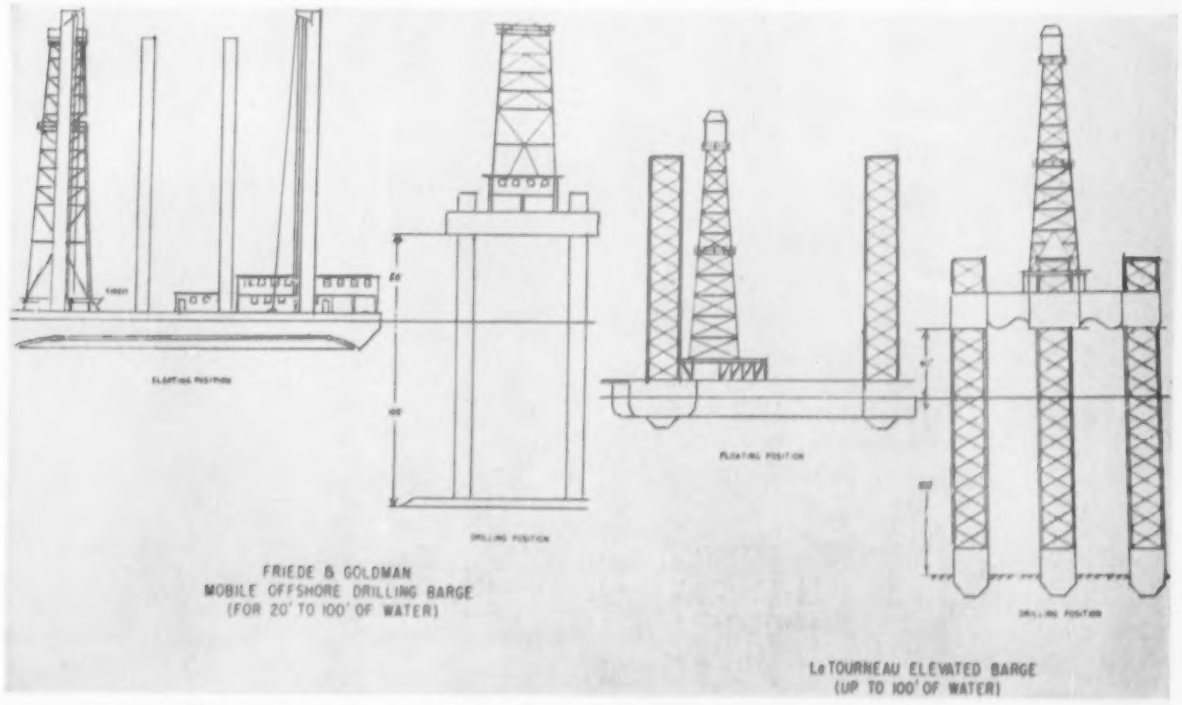


Fig. 6 Friede and Goldman and LeTourneau types of drilling barges

draulic lifting pumps or electric motor gear elevating mechanisms.

So far no device has been constructed and tested for operating in water of a depth greater than 100 ft, but such devices are almost certain to appear in the next few years, not only for drilling in the Gulf of Mexico on the Continental Shelf, but also for use in the deep waters which are close offshore in California.

Design Considerations

The design of any of these offshore drilling structures is a major engineering undertaking, and so far there has not yet been found a precise mathematical means of doing so. Calculations to allow for a wind velocity of

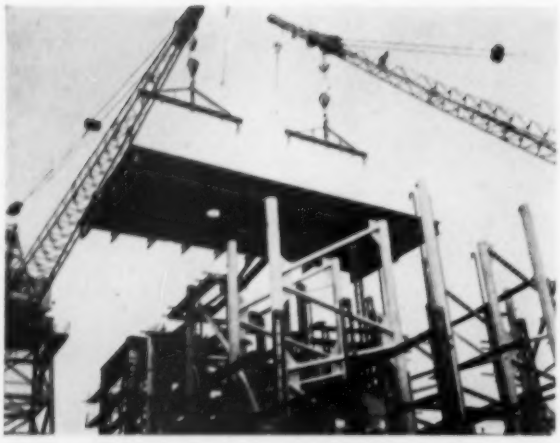


Fig. 7 Handling 58-ton upper platform assembly

hurricane force are well known in civil engineering practice, as are the usual methods of structural design to allow for the weights of equipment carried on the platform. How to allow for the effect of storm waves, however, is another matter. Oil companies have spent hundreds of thousands of dollars on research in order to determine the forces developed by waves of varying proportions, and while considerable useful data exists at the present time, it must be applied with considerable caution and with a generous factor of safety.

While hurricanes present the worst conditions to be expected and must be allowed for, line squalls having winds of nearly hurricane force are in some respects more troublesome. Hurricanes can usually be forecast 24 to 72 hr ahead, while radar will give but a few hours notice at best of impending squalls.

Most offshore drilling structures are designed to have a clearance above still water of 30 to 40 ft, although a few designs allow as much as 50 ft. Generally, in deeper water a higher wave may be expected and more clearance is required.

The coast of Texas in most areas has a bottom consisting of hard sand, which offers a good support for submersible barge hulls and good resistance to piling. The coast of Louisiana, however, is mostly soft mud and silt and particularly at the mouth of the Mis-

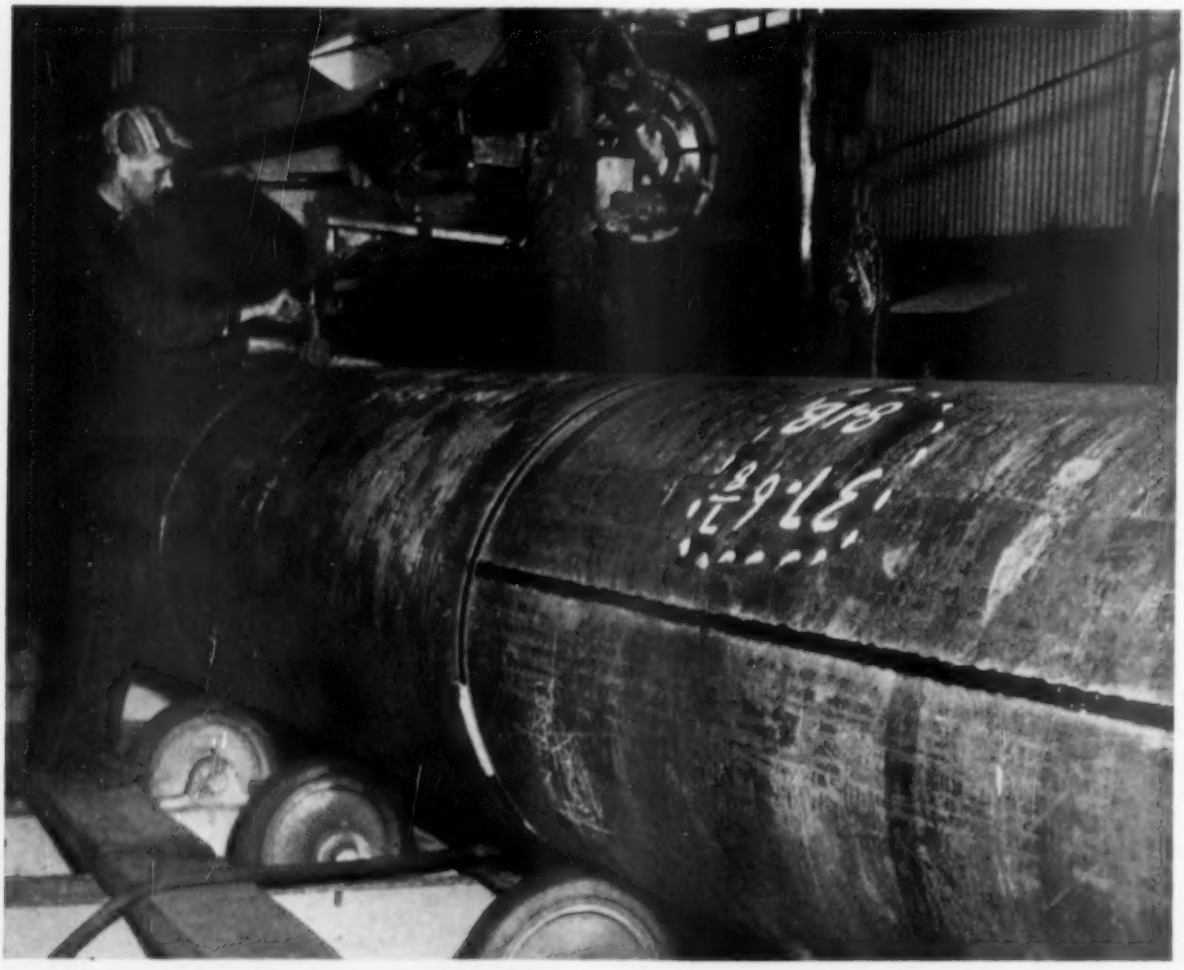


Fig. 8 Positioners and automatic welding equipment for column fabrication

sissippi River, the bottom is hardly more viscous than water and has a very limited load bearing value, not over 400 lb per sq ft. In such soil it has been found that the hulls of submersible barges sink into the bottom somewhere between 5 and 8 ft, while rigid pile structures have utilized in some cases piles as long as 450 ft, of which all but 60 ft are down in the mud.

Nearly all offshore drilling barges employ columns in one form or another to support the drilling platform. In submersible barges these columns rest on the submerged hull and great attention has to be paid to distributing the forces from these columns through the hull structure in such a way that a uniform bottom load results. This is not only to prevent overstresses in the structure but to eliminate uneven settling in the mud.

There is always a possibility that a submerged barge will stick in the mud when the time comes to raise it, and if the tanks are pumped out for this purpose, the resulting hydrostatic pressure on the hull is considerable and in some cases, especially in deep water, results in very heavy structure. This is one of the reasons why submersible type hulls are usually considered to be limited to maximum water depths of somewhere around 65 ft. To help reduce sticking to the bottom, suction break lines are employed which supply streams of jetting water which are of some assistance in breaking the hull loose.

Stability is one of the most important problems of design. Stability afloat before reaching location may be a serious problem if the barge is completely loaded with mud, cement, pipe, equipment, supplies and with the derrick erected. This problem is aggravated in the elevating hull type, where during transportation the large diameter caissons extend 100 ft or more in the air above the hull.

Stability during the period of sinking and raising is especially critical at the point where the main hull is just under the surface of the water, during which time it no longer contributes to the stability of the unit and total reliance is placed on the pontoons. At this point if the barge were to capsize, it would be very serious. When the hull is close to the bottom, however, due to the great widths that are commonly employed, a condition of instability would not be too serious because a small angle of inclination would result in one side of the barge touching the bottom, restoring the stability at least to a partial degree.

Once on the bottom, there is considerable danger from scouring due to the effect of underwater currents and storm waves. This results in the piling up of the soil on one side or one end of the barge and an erosion on the opposite side. Eventually, this can cause uneven settlement of the hull and possible structural difficulties due to the loads imposed on the portion which has lost its bottom support. Experiments have been performed to adopt special shapes such as wedges and curves to reduce scouring. In other cases old barges and surplus Navy hulls have been sunk to the bottom forming a crescent around the submerged barge to act as underwater breakwaters.

Welding

All portions of drilling barges are of very heavy construction, not only the hull and columns but the upper platform as well. Shipyards which have adequate crane capacities make assemblies of exceptionally large sizes on the ground, which are later erected in place. Figure 7 shows a 58-ton upper platform assembly for a drilling barge which represents one of three similar lifts.

Fig. 9 View of columns, bracing and hydraulic rams, looking up from below

The construction of the hulls of drilling barges presents few problems in welding, other than the special care that has to be taken to distribute the column loads as mentioned heretofore. Also, due to the high hydrostatic heads encountered, exceptional care is required in welding and thorough inspection and testing is of the greatest importance.

Most of the welding problems center around the construction of the columns. It has been found that the assembly of columns in short sections makes it possible to keep them straighter than to attempt to form long lengths. The short sections are in the neighborhood of 6 to 8 ft long and are rolled into columns, having diameters of 24 in. up to about 36 in. Each of the column sections has its longitudinal weld completed first and an attempt is made to maintain an out-of-round tolerance of around $^1/_8$ to $^3/_{16}$ in.

Each of the completed short sections is then put together and automatically welded as shown in Fig. 8, and a departure from straightness of not over $^1/_4$ in. is main-

tained on lengths of around 40 ft.

Each column is erected on the hull as a free standing column and a skip welding sequence is used all around by means of which the columns can be regulated and maintained plumb. The intersections of diagonal members present some problems and require either internal rings or gussets of minimum proportions. Care must be taken to balance the welding on such intersections to minimize distortion. The final column and bracing assemblies are fairly complicated, as shown by Fig. 9.

The vertical guide rails on which the pontoon attachments slide extend the entire height of the columns and beyond, and are required to transmit very large reactions from the pontoon rams. They are fabricated of $1^{5}/_{8}$-in. plate, and must be maintained straight within $^{1}/_{8}$ in. in a length of 61 ft 6 in., requiring the utmost care in welding sequence.

Figure 10 shows a drilling barge structurally complete and ready for launching.

Conclusion

At the present stage of development of offshore drilling, no one can say what is the right equipment for a particular location or water depth. There has been insufficient experience in operating the different types of rigs and not enough cost data to determine which is the safest and most economical. Furthermore, there has been but very little exposure of these rigs to severe hurricanes and until more data are secured on the effect of wind and wave combined, designers will be uncertain as to whether they have allowed too large or too small a factor of safety in design. New designs are being developed daily and it may be many years before the ultimate equipment is developed.

Acknowledgment

The author wishes to express his appreciation to the following organizations for supplying the needed illustrations: to the Ingalls Shipbuilding Corp. for Figs. 5, 7, 8, 9 and 10; to the California Co. for Fig. 1; to Kerr-McGee Oil Industries, Inc., for Fig. 2; to the Ocean Drilling and Exploration Co. for Fig. 3; to the Offshore Co. for Fig. 4; and to E. N. Kemler and E. W. Rosencrants for Fig. 6.

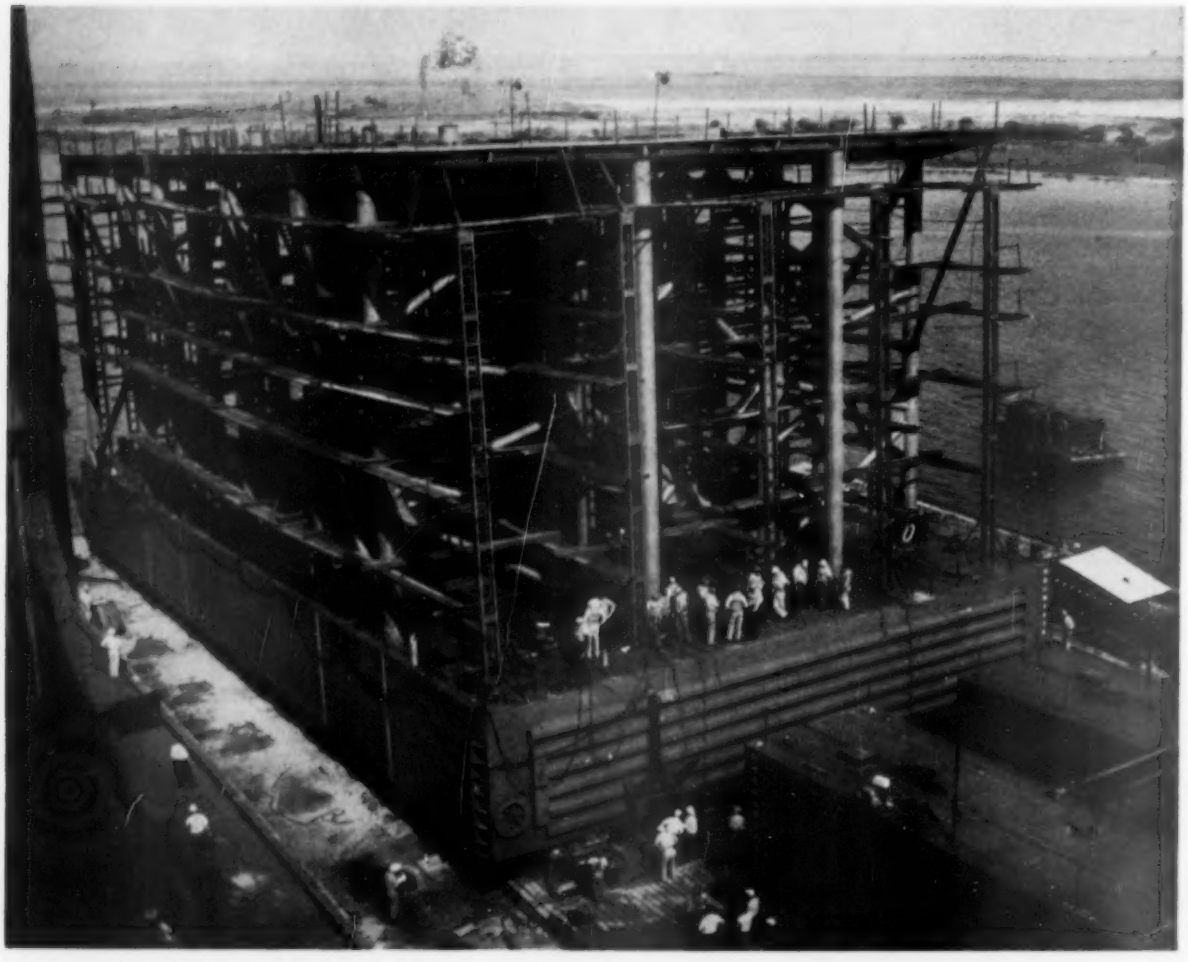


Fig. 10 Drilling barge ready for launching

Pressure piping being welded with chrome-moly electrodes

WELDING OF HIGH-TEMPERATURE HIGH-PRESSURE PIPING WITH CHROME-MOLY ELECTRODES

Chrome-moly E-XX15 low-carbon, low-hydrogen electrodes have been developed to produce satisfactory welds on ferritic chromium-molybdenum steels

BY LLOYD C. NESBITT

Chrome-moly Type E-XX15 low hydrogen electrodes, with carbon content held at 0.05% max and with a straight lime coating, were developed because none of the previous formulations recommended for welding the ferritic chromium-molybdenum steels has produced a weld deposit having all of the characteristics required for completely satisfactory welds on these base metals.

It is the purpose of this paper to discuss the coating characteristics of the E-XX15 electrodes, to describe their mechanical properties and metallurgical advantages, to explain the beneficial effects resulting from low carbon and from exclusion of undesirable gases and entrapped slag from the weld deposit and to outline welding procedures recommended when using them.

In order to properly evaluate E-XX15 electrodes, however, it is necessary to have a basis for comparison. We shall, therefore, first briefly review the history of welding chrome-moly steels and describe the characteristics of various types of electrodes previously

Lloyd C. Nesbitt is Field Engineer, Metal & Thermit Corp., New York, N.Y.

Presented at AWS National Fall Meeting in Philadelphia, Pa., Oct. 17-21, 1955.

Fig. 1 Low as-welded ductility of weld metal made with silicon-killed core wire; 8–15% elongation in 2 in., 30–50% reduction of area

available for this work.

Other Type of Chrome-Moly Electrodes

The chrome-moly steels were developed for use in steam boiler and steam piping applications at temperatures from 900 to 1200° F. They have also been widely used in process piping in the oil, chemical and other related industries where corrosion resistance and elevated temperature properties are important factors.

Welding these steels has presented some difficulty due to brittleness and low ductility caused by their tendency to air harden while cooling. In order to compensate for low ductility of weld deposits made with conventional electrodes, it has been necessary to employ high preheat temperatures and to maintain them until the weld has been postheat treated.

Silicon-Killed Core Wire Electrodes

The early chrome-moly electrodes employed conventional coatings on silicon-killed chromium steel core wire. These electrodes usually deposited weld metal containing large amounts of occluded hydrogen, and in excess of 0.08% carbon. The absorbed gases combined with the high carbon content naturally produced brittle weld deposits; in order to avoid cracking it was necessary to maintain a high preheat

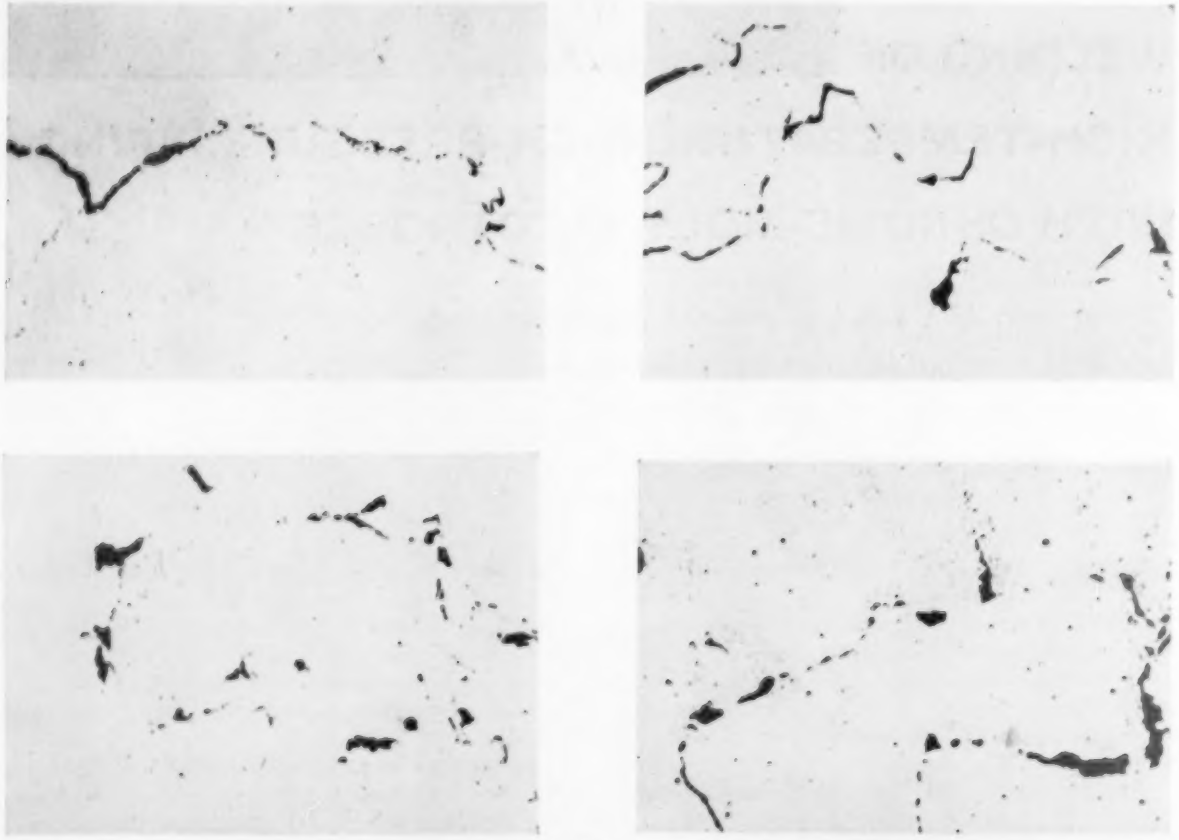


Fig. 2 Microfilms present in $2^1/_4$ chromium weld metal which was deposited using electrodes containing a silicon-killed chrome-moly core wire

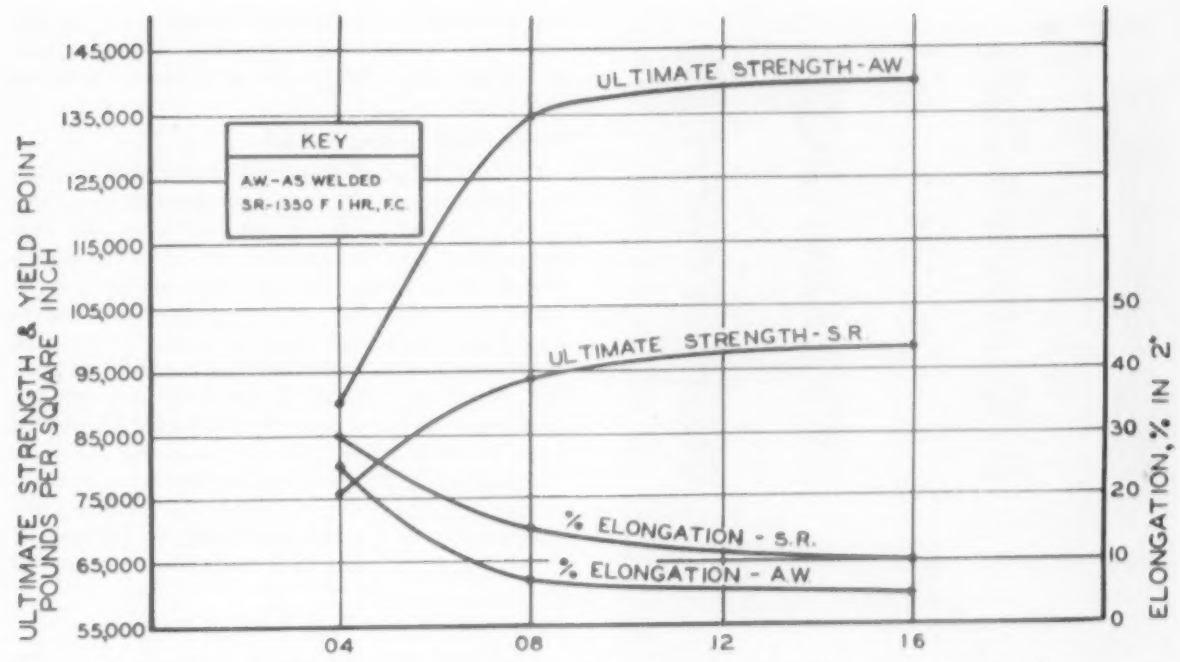


Fig. 3 The effect of carbon content on room temperature mechanical properties of $2^1/_4$ chromium weld metal

during welding and to postheat treat immediately to restore ductility to the weld deposit.

The low as-welded ductility (8 to 15%) of low-hydrogen chrome-moly coated electrode weld deposits made with silicon-killed core wire is shown in Fig. 1.

Another cause of weld metal cracking was intergranular filming resulting from massive silicate inclusions in the silicon-killed core wire. Figure 2 shows this silicate filming.

25Cr – 20Ni Electrodes

The 25Cr – 20Ni electrodes have also been used by some fabricators for welding chrome-moly steels because of the good as-welded ductility of this weld metal. The normally good corrosion resistance of the 25Cr – 20Ni weld deposit, however, is impaired in many oil industry applications where welds are exposed to sulfur-bearing media. 25Cr – 20Ni weld deposits, like other fully austenitic weld metals, are susceptible to microfissuring and exhibit a tendency to cracking due to difference in the coefficients of expansion of the weld metal and the chrome-moly base metal.

Cellulose-Coated Chrome-Moly Electrodes

Coating formulations of other chrome-moly electrodes available commercially today are classified under specifications of the American Welding Society and the American Society for Testing Materials as E-XX10, E-XX11, E-XX13 and E-XX16. The inherent advantages and disadvantages of these different coatings will be discussed.

E-XX10 is a cellulose-coated chrome-moly electrode for d-c reverse polarity welding in all positions. Decomposition of the large amount of cellulose in the coating results in a weld deposit high in hydrogen. The carbon content of E-XX10 weld metal is frequently as high as 0.08% or more, which is also disadvantageous. These electrodes, nevertheless, have been widely used; their small slag volume, which may easily be removed from the weld, gives them good weldability in all positions.

E-XX11 is a cellulose-coated chrome-moly electrode for all-position welding with either reverse polarity direct current or alternating current. Their general characteristics are very similar to those of E-XX10 electrodes.

E-XX13 is a titania-coated chrome-moly electrode for welding in all positions on either reverse polarity d-c or a-c current. Their high titania content gives them excellent weldability and the weld beads have a pleasing appearance; the weld deposit, however, is high in occluded hydrogen and in carbon. The deposits are susceptible to slag entrapment along the edge of the bead, due to a large volume of slag produced by the E-XX13 coating. The bead is convex in shape, and the viscous slag tends to cling to the edge of the bead and does not flow away before freezing, causing slag entrapment.

While E-XX10, E-XX11 and E-XX13 types offer excellent weldability, their hydrogen and carbon contents produce deposits of very low ductility in the as-welded state. Hydrogen embrittlement is also believed to be a principal factor in underbead cracking in the weld area of the base metal.

Lime-Titania Coated Electrodes

E-XX16 is a lime-titania coated chrome-moly elec-

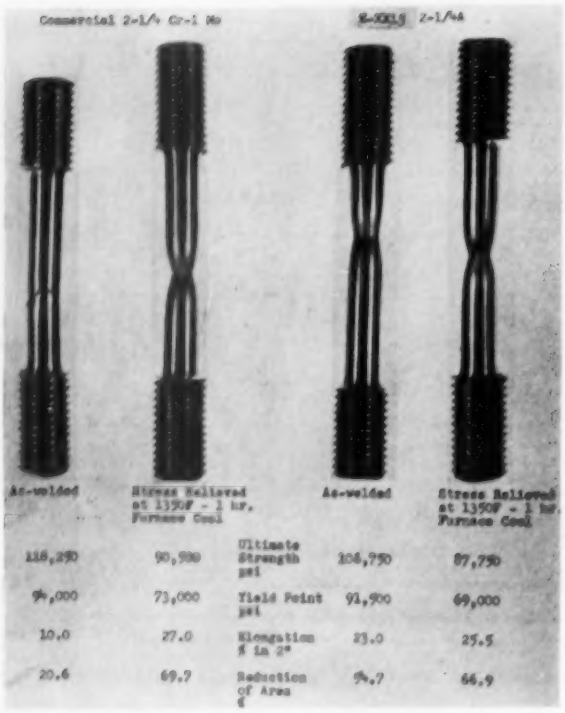


Fig. 4 Comparison of room temperature mechanical properties; E-XX15 $2^1/_4$A and commercial $2^1/_4$Cr – 1Mo weld metals

trode suitable for welding in all positions on either d-c reverse polarity or a-c. The lime-titania coating is superior to the cellulose coating since it contains no ingredients that produce hydrogen. The carbon content of these electrodes is relatively high, however, and this, together with an oxidizing slag tends to impair the properties of the weld deposit.

Research Leading to E-XX15 Type

Extensive studies of the properties of conventional chrome-moly weld metals indicated that good as-welded ductility could be obtained in chrome-moly weld metals containing from 1 to 5% chromium and $^1/_2$% to 1% molybdenum, by reducing the carbon content below 0.05%. Figure 3 shows the comparative as-welded ductility of two specimens of $2^1/_4$ chrome-moly weld metals containing 0.04 and 0.08% carbon, respectively. The low carbon deposit showed 26% elongation, nearly four times the 7% elongation of the weld metal with the higher carbon content.

These studies further established that by excluding absorbed gases such as hydrogen, while keeping the carbon content at a low level, it is possible to minimize the low ductility and resultant brittleness. It was found that use of a special low carbon rimmed steel core wire and a straight lime coating produced a sound, clean weld metal, free from hydrogen gas and highly ductile.

From a metallurgical point of view, the selection of the lime coating follows the same principles that apply to good steelmaking. Some of our finest steels are produced in the basic electric arc furnace, using a basic slag to purify and protect the molten steel. In the same way, the basic slag of the lime coating helps to exclude impurities and gaseous contaminants from the weld metal deposit.

Preliminary Testing Period

Having established that low-hydrogen lime coatings on a low-carbon steel core wire produced cleaner, more ductile, gas-free welds, chrome-moly electrodes containing from 1 to 5% chromium and $^1/_2$ or 1% molybdenum were formulated and shop-tested in the fabrication and assembly of high pressure steam equipment for five years with excellent results. These weld metals produced as-welded ductility ranging from 20 to 27% elongation. Figure 4 shows the improvement in ductility obtained from low-hydrogen, low-carbon Type E-XX15 $2^1/_4$ chromium weld metal compared with commercial $2^1/_4$ chromium weld metal. Ductility of this high order almost completely eliminates the danger of cracking under practically all conditions of preheat, postheat, interpass temperature or rate of cooling.

Characteristics of Type E-XX15 Electrodes

The E-XX15 chrome-moly electrode is an all-position electrode for use with d-c reverse polarity current. The basic slag resulting from the lime coating effectively removes impurities from the weld metal and contains no hydrogen producing compounds to adversely affect the properties of the deposit.

E-XX15 electrodes are exceptionally suitable for use when welding free-machining, sulfur-bearing steels and heavy plate containing sulfide inclusions. Since the basic slag readily absorbs the sulfur, they overcome the usual danger of contamination from this source. The nature of the slag also aids in precise control of the chemical analysis of the weld deposit, particularly the important low carbon content.

An important aid in avoiding entrapment of slag is the directional arc characteristic of this electrode formulation. When welding along the sidewall of a groove, the arc automatically directs itself toward the sidewall. The action washes the sidewall and prevents the entrapment of slag at that point.

Spatter losses are unusually low, due to the heavy coating and low moisture content of these electrodes. Their stable arc action deposits a weld bead of fine ripple and pleasing appearance.

Storage of E-XX15 Electrodes

The lime-coated, low-hydrogen electrodes must be perfectly dry to deliver optimum results. Once their moistureproof containers have been opened, it is necessary to protect the electrodes at all times from moisture which can be absorbed from a humid atmosphere. They should be stored at a temperature somewhat above ambient. Storage in a cabinet heated by ordinary light bulbs is recommended. In exceptionally humid atmospheres the electrodes should be heated in a short section of clean tubing to approximately 250° F for a few minutes before welding. There are commercially built ovens on the market that serve

Table 1—Chemical Analysis of Weld Deposits

	C	*Mn*	*Si*	*Cr*	*Mo*	*S*	*P*
E-XX15 1A	0.05 max	0.30–0.80	0.75–1.00	1.00–1.25	0.40–0.65	0.03 max	0.02 max
E-XX15 2A	0.05 max	0.30–0.80	0.75–1.00	1.80–2.20	0.40–0.65	0.03 max	0.02 max
E-XX15 2¼A	0.05 max	0.30–0.80	0.75–1.00	2.00–2.50	0.90–1.10	0.03 max	0.02 max
E-XX15 5A	0.05 max	0.30–0.80	0.75–1.00	4.00–6.00	0.40–0.65	0.03 max	0.02 max

Table 2—Mechanical Properties of E-XX15 Welds

Electrode	*Properties*	*As-welded*	*Postweld heat treatment* 1150° F	1350° F
E-XX15 1A	Tensile strength, psi	87,000	84,740	76,000
	Yield point, psi	71,370	66,500	57,000
	Elongation, %	26.0	29.0	31.0
	Reduction of area, %	64.3	66.2	70.7
E-XX15 2A	Tensile strength, psi	107,750	101,290	82,250
	Yield point, psi	88,500	80,820	66,000
	Elongation, %	27.0	22.0	30.0
	Reduction of area, %	65.3	64.6	71.9
	Charpy impact, ft-lb	37.0	...	63.5
E-XX15 2¼A	Tensile strength, psi	102,000	101,700	81,500
	Yield point, psi	84,500	81,560	64,500
	Elongation, %	24.0	21.0	29.0
	Reduction of area, %	52.7	57.1	68.1
	Charpy impact, ft-lb	36.0	...	64.0
E-XX15 5A	Tensile strength, psi	120,250	...	91,000
	Yield point, psi	106,500	...	77,000
	Elongation, %	19.5	...	25.0
	Reduction of area, %	56.5	...	72.4
	Charpy impact, ft-lb	22.0	...	59.5

quite well in maintaining these electrodes in proper condition.

Metallurgical Advantages

The increased ductility resulting from the lower carbon content of E-XX15 electrodes provides four noteworthy metallurgical advantages:

1. Weld cracking has been practically eliminated.
2. Preheat temperatures have been lowered.
3. Many welds may be allowed to cool to room temperature without postheat treatment.
4. Unless applicable codes require mandatory heat treatment, welds of sections below 1 in. in thickness may be placed in service without postheat treatment.

Chemical Analysis of Weld Deposits

E-XX15 electrodes are available in four diameters: 3/32, 1/8, 5/32 and 3/16 in. They are also furnished in four numbered grades: 1A, 2A, 2¼A and 5A—the numbers designating the approximate percentage of chromium in the formulation.

Table 1 details the nominal chemical analysis of weld metal deposits of each of the four grades. Briefly, the carbon content is held below 0.05% max for all four grades. The range of manganese, silicon, sulfur and phosphorus likewise remains constant for all grades. The molybdenum content is 0.40 to 0.65 for Nos. 1A, 2A and 5A; and 0.90 to 1.10 for No. 2¼A. The range of chromium content is as follows: 1A, 1.00–1.25; 2A, 1.80–2.20; 2¼A, 2.00–2.50; 5A, 4.00–6.00.

Mechanical Properties

The low-hydrogen, low-carbon weld metals have excellent room and elevated temperature properties, both as-welded and after postweld heat treatment. Ductility of low carbon (0.05% max) welds in the as-welded condition compares favorably with that of 0.08% carbon welds, after postweld heat treating.

Mechanical properties of E-XX15 welds are listed in Table 2. A review of these properties reveals that a slight reduction in the tensile and yield strengths occurs during postweld heat treatment. The as-welded impact strengths adequately meet normal requirements and are similar to as-welded impact strengths of E-6010 electrodes.

Table 2 indicates in general that the mechanical properties of these weld metals are more than satisfactory in either the as-welded or the postweld heat-treated condition. The as-welded ductility equals that of the 25Cr–20Ni weld deposits. If heat treatment is required, the weld metal properties are almost unaffected.

The high temperature properties of E-XX15 weld deposits are equal to or better than wrought materials having the same chemical analysis.

Carbon Migration

In order to prevent the phenomenon of carbon migration during postweld heat treatment, or at service temperatures above 1000° F, the chromium content of base material and weld metal should be matched as closely as possible. A difference of 0.25% in chromium content may be sufficient to cause the carbon to migrate from the lower to the higher chromium steel. Figure 5 shows the effect on carbon migration of dif-

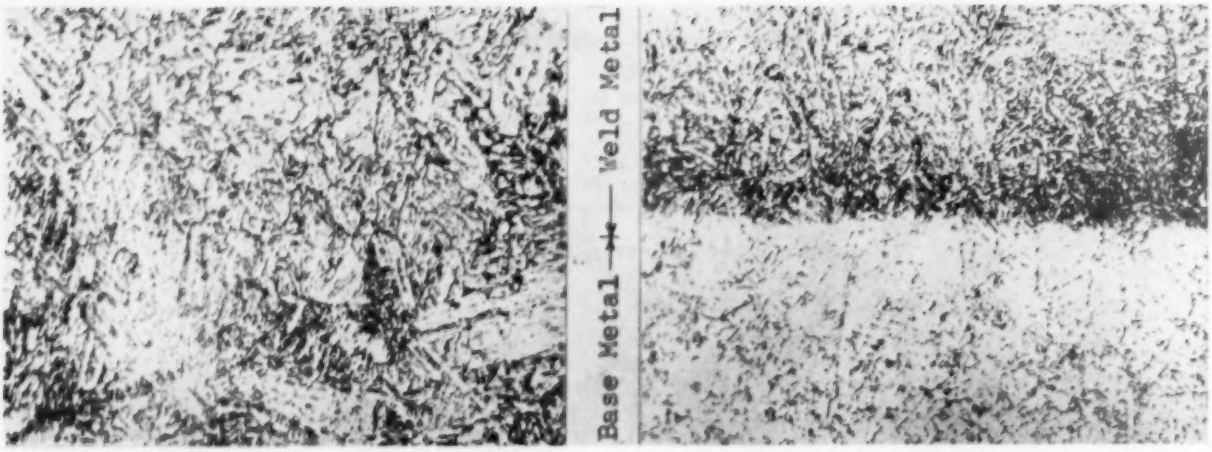


Fig. 5 Line of fusion between $2^1/_4$ chrome-moly tubing and E-XX15 2A and 5A weld metal after exposure to 1350° F for 36 hours. Note absence of carbon migration between $2^1/_4$ chrome-moly base metal and E-XX15 2A weld metal, and presence of carbon migration in weld with 5A weld metal. Etchant, 4% Nital; magnification, 250 X

ferences in chromium content.

While authorities disagree as to the effects of carbon migration upon the strength of the weld, many joints between 2 and 5% chrome-moly steels, welded with 2% chromium electrodes have withstood long periods of service with no known failures that could be traced to carbon migration.

Other studies have shown that close matching of the chromium content prevents carbon migration between higher carbon (0.15%) chrome-moly base metal and low carbon (0.05%) weld metal. Figure 6 shows the absence of carbon migration in a joint between $2^1/_4$ Cr – 1Mo base metal (0.15% carbon) and a $2^1/_4$ chromium weld metal (0.05% carbon max).

Relation of Properties to Applications

The properties already described give these electrodes a wide range of usefulness wherever chrome-moly steels are used in high temperature, high pressure service.

Their excellent creep-rupture strength and oxidation resistance make them suitable for elevated temperature applications in the power industry. The weld metals also have superior resistance to the hydrogen attack at moderately elevated temperatures encountered in the oil and chemical industries.

Other applications are found in process equipment wherever excellent high temperature properties and good corrosion resistance are important.

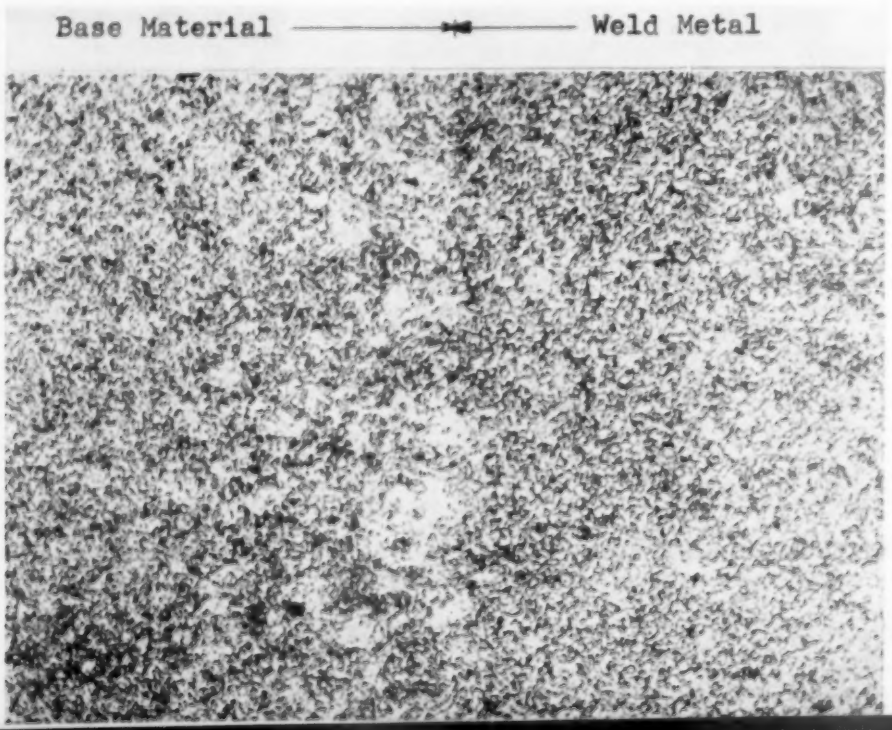


Fig. 6 Line of fusion between $2^1/_4$ chrome-moly base material (0.15% carbon) and a $2^1/_4$ chromium weld metal (0.05% carbon) showing absence of carbon migration after exposure to 1350° F for 36 hours

Selection of Electrode Size

Recommended current ranges for E-XX15 chrome-moly electrodes are somewhat above those used for conventional electrodes of the same diameter. Recommended amperages for the various electrode diameters are as follows:

Electrode diameter, in.	*Current, amp.*
3/32	80–100
1/8	110–150
5/32	150–190
3/16	190–220

It will be recognized that an electrode should be selected which is one size smaller for a given amperage than that which would normally be used if a cellulose coating were to be employed. In other words, a 1/8-in. diam E-XX15 requires about the same current input as a 5/32-in. diam E-XX10.

Selection of too large a diameter for the current employed should be carefully avoided; it will result in poor operating characteristics and may even produce porosity and slag entrapment in the weld. Use of a size larger than recommended results in a rather cold weld puddle with attendant danger of trapped slag and occluded gases.

Weld Groove Preparation

Since the low hydrogen coating produces a comparatively heavy slag volume, a root opening of sufficient width should be provided to permit proper manipulation of the arc to insure good penetration. If no root opening can be provided, the included angle should be not less than 90°. When it is possible to provide a root opening of 1/8 in. or more, the angle may be reduced to 60° or less, depending on the width of the opening.

Where possible, it is recommended that the joint be fitted with a backing ring to protect the first pass of weld metal from oxidation on the under side. Tubular joints can be successfully welded without a backing ring, however, if the electrode chosen is of sufficiently small diameter to operate properly at the current employed.

Precleaning the Weld Area

Particular attention must be paid to careful precleaning of the weld area. The joint must be free from rust, scale, grease or any other foreign material.

Due to the protective quality of the formulation, these electrodes deposit a fully killed weld metal. For this reason, the accidental inclusion of any source of oxygen, such as iron oxide or extraneous carbon such as oil will adversely affect the quality of the deposit. Contaminants allowed to be present in the weld area may cause pinhole pores in the weld or may increase the carbon content.

Preheat Requirements

Preheat temperature for a given job depends upon many variables, among them wall thickness, geometry and chemical composition. Some preheating is always recommended for chrome-moly welding; however, when using E-XX15 electrodes, preheat temperature may be 100 to 200° F below that normally considered necessary for these steels.

It is customary when using most commercial chrome-moly electrodes to maintain the preheat until the postweld heat treatment can be applied. When using the more ductile low hydrogen, low carbon electrodes, however, pipes or tubing with a wall thickness not in excess of 1 in. may be allowed to cool to room temperature before postweld heat treating.

Welding Techniques

These electrodes have excellent usability, and the welder, by observing a few simple precautions, should be able to deposit clean, sound weld metal. It is important to remember that these weld metals are protected by a basic slag rather than a gaseous atmosphere as in the case of the cellulose coatings. It is therefore essential to maintain a very short arc to prevent introduction of air, which may result in oxidation of the weld metal. It is also necessary to avoid excessive tilting of the electrode, since tilting also allows air to enter the arc zone. In general, the electrode should therefore be maintained at an angle of 90° to the work. This may initially seem difficult to accomplish in pipe welding but it will be found that most operators quickly learn to manipulate the electrodes. A deviation of 5 to 10°, moreover, will not cause unsatisfactory results.

It is preferable that a weaving technique be used, to slow down the rate of cooling of the weld puddle. To avoid slag entrapment, the arc should never be directed into solidified slag. In practice, the width of the weave is limited by the ability of the welder to keep the slag molten. A weave width three times the electrode diameter is good practice.

Each weld bead should be carefully cleaned of slag before the next bead is deposited. As a further aid in avoiding slag entrapment, the welding progress should always be in an upward direction when welding in any position except flat.

Postweld Heat Treatment

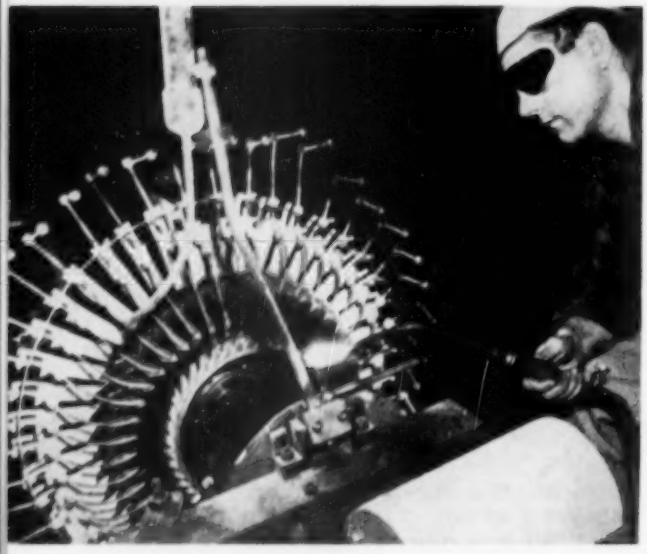
Postheating requirements vary with the application and dimensions of the weldment and with the provisions of applicable codes. Since the electrodes under discussion offer excellent as-welded ductility, postheat treatment temperature will be established by the mechanical properties desired.

Whenever a postheat treatment is required, temperatures from 1175 to 1375° F are commonly used. Temperatures higher than 1375° F are usually avoided to prevent heating into the critical temperature range.

As to duration of postheat treatment, it is a common practice to hold the temperature for one hour for each inch of thickness.

Unless code requirements demand it, postheat treatment may be eliminated on chrome-moly weldments 1 in. or less in thickness, when welded with the low carbon, low hydrogen E-XX15 electrodes.

MECHANIZED BRAZING OF FAN COMPONENTS



Rotor assembly being preheated prior to brazing

Large savings are realized with unique semiautomatic brazing method using a powdered filler metal and the proper flux

BY FRANK G. LEUTHNER

Introduction

The fan components which this article describes is the *rotor* and *stator* see (Figs. 1 and 2). The rotor supplies the air and the stator, which is mounted immediately to the rear of the rotor at assembly, causes the air to flow into a usable path. The function of this assembly is to supply cooling air to cool the oil used in a torque converter drive. The great number of blades (41) together with the long leading edge, curved tips, and high rotating speed enables this rotor or fan to do an unusually big job for its size. This 14-in. diam fan assembly produces 6000 cfm at 10 in. H_2O at 4600 rpm. Another design feature which adds to the efficiency is the addition of boundary layer blades to the leading edge of the *stator blades*.

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Presented at AWS 1955 National Fall Meeting held in Philadelphia, Pa. Oct. 17-21.

The usual method of silver brazing using a hand held torch and brazing alloy was very costly, difficult and time consuming due to the complex design and great number of blades (41 in the rotor and 47 in the stator). In addition the problem was made more acute by the high volume of production required. A total of 1.3 man-hours was needed to hand braze a single assembly. No matter how skilled the operator, slight differences in uniformity of brazing metal distribution caused excessive unbalance in the fan assembly and only slight variations in heat application produced blade distortion. Since skilled brazing operators were difficult to

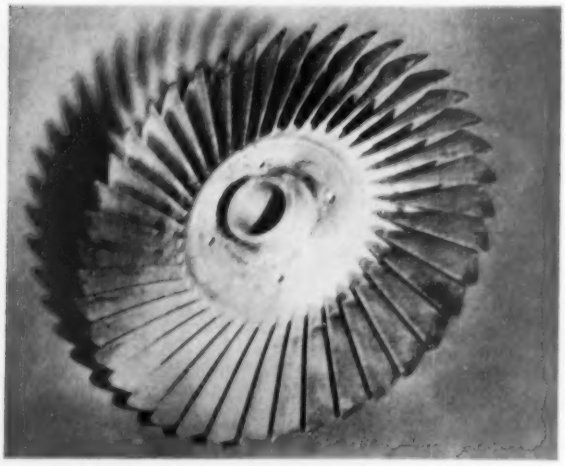
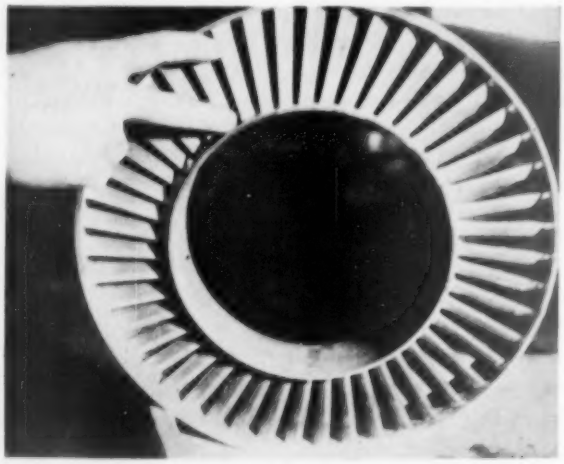


Fig. 1 Rotor

Fig. 2 Stator



obtain or train, production was extremely limited. Further, the need for the accommodation of an eddy-current clutch within the rotor hub left little space, and high rotational stresses made any type of mechanical attachment impossible.

General Description

The most important fact to remember in the development of the automatic brazing equipment is that the rotor assembly presented a more difficult problem than that of the stator. Simply, this is due to the high rotating speed of the rotor and that the stator is stationary. During stress check or whirl test, when the rotors are spun at 20% over maximum operating speed, a direct pull of 1500 lb per blade is produced on the brazed joint. The extreme curvature and the complex formation of the surface to be brazed complicated the problem.

The stator blade was, in comparison, a relatively flat surface and brazed in two places at both the inner and outer tips. Also, after the stator blade was correctly cut and shaped, an almost perfect hook was formed at the inner tip which tended to lock the blades in position over the inner ring on the brazing fixture (see Fig. 3).

Since silver brazing was the best method of joining the blades to the hub and rings, our next step was to simplify, perfect and speed up the process. In order to obtain an even distribution of heat we designed the present method of rotating the entire assemblies. The blades had to be held in place while rotating and, since expansion could not be eliminated while the assembly was coming up to brazing temperature, a combination blade holding clip and spacer was devised (see Fig. 4). These not only held the blades against the hub; but, also retained the blades in their same relative position as the hub expanded.

Again, positioning the stator blades did not pose so great a problem as the outside ring held the blades in position. Another aid was that the whole assembly was brazed while still clamped in the setup fixture.

This stator setup fixture as well as the rotor blades and hub setup device proved to be the ideal method of matching blades to rings and blades to hub. These setup fixtures which consisted of annular rings with dowel pins placed to hold and space the blades permitted a complete setup in one operation. As mentioned before, the stator setup plate also performed as a brazing fixture.

The fluxing method which was finally selected is shown in Figs. 4 and 5. A paste type flux is used and is boiled for several hours to drive off all excess moisture. This flux is applied with a brush over an area extending slightly beyond the blade widths (see Fig. 5). This is done to insure a good braze weld over all the contacting surfaces. The silver solder will not flow over any area where flux has not been applied. A point that might be mentioned at this time is that it would be difficult to classify this kind of flux, that is, a flux which does not contain enough water, as a "paste"; at the same time, it is not dry enough to be called a "powder." Later, some of the methods which were tried and found unsatisfactory will be explained.

Another problem was to secure the best method in obtaining the desired fit of the blades to the hub (see Fig. 6). The joint strength varied due to the class of fit and any clearance in excess of 0.008 in. could not be tolerated. Milling and grinding were tried in that

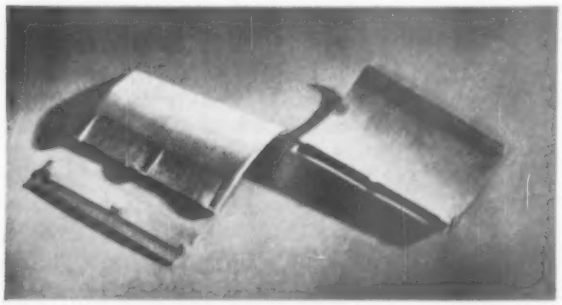


Fig. 3 Stator blade and boundary layer blade assembly

Fig. 4 Rotor setup fixture showing combination blade holding clip and spacer assembly

Fig. 5 Applying paste type flux

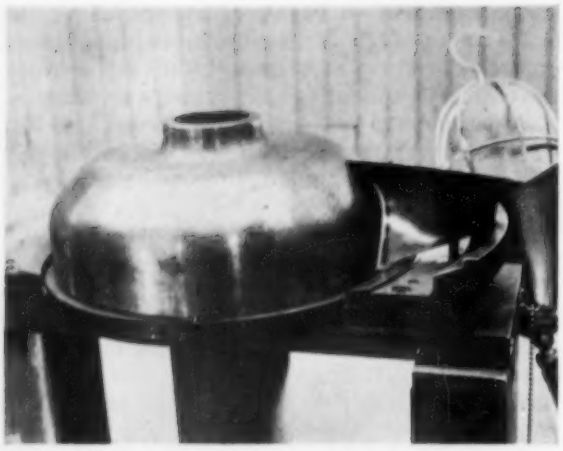


Fig. 6 Tolerance checking fixture

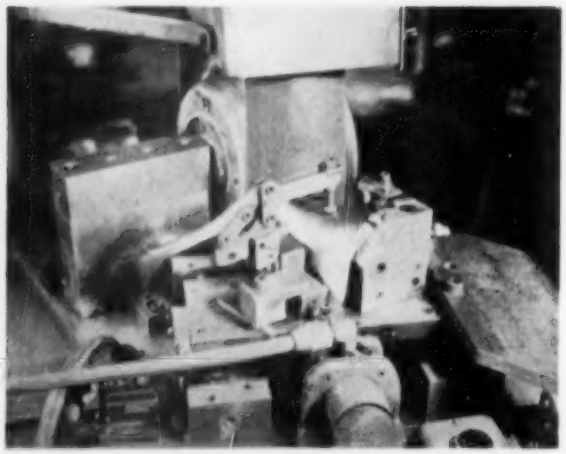


Fig. 7 Belt sander with contoured wheel and automatic hydraulic feeding device

Fig. 8 Rotor holding fixture being lowered over rotor assembly

order and both proved unsatisfactory. The third and most successful method was that of using a belt sander to run an abrasive belt over a contoured wheel simulating the hub. By using an automatic hydraulic feeding device, production of finished blades was increased from 100 blades per man-hour to 260 or an increase of 160% on one machine (see Fig. 7). Two machines could actually be operated side by side by one operator, if necessary, and triple production.

A holding fixture was devised for the rotor assembly (see Fig. 8). This is lowered over the assembly and held concentric to the hub by a central spindle. Each blade is held at its center of gravity by a clip, and to the fixture by a spring loaded finger (see Fig. 9). This holding fixture together with the hub and blade assembly is at this time in a vertical position. This complete assembly is then rotated to a position about 20 deg from the horizontal (see Fig. 10). It is in this position that the brazing operation is performed and was arrived at after many positions had been tried unsuccessfully.

The stator brazing operation is much simpler because, as mentioned before, the set-up plate also acts as the brazing fixture. After the inner ring and blades have been assembled (see Fig. 11), the outer ring is clamped about the assembly, the complete stator assembly rotated to a horizontal position (the surfaces to be brazed are flat); then, the joint in the outer ring is arc welded (see Fig. 12), and the assembly is ready for silver brazing.

Each fixture rotates at about 2 rpm. With neither fixture does the flame from the torch play directly on the surface to be brazed. This serves the double purpose of preventing possible carbonization of solder and flux and prohibits excessive blade heating. On the rotor fixture, the flame plays on the inside of the hub. On the stator fixture, one torch plays a flame on the inside of the inner ring and another applies the flame to the outside of the outer ring (see Fig. 13). In all three cases, the heavier mass of metal is heated first and the blades are only heated to a height of $\frac{1}{4}$ in. at brazing temperature (about 1150° F). One may notice when

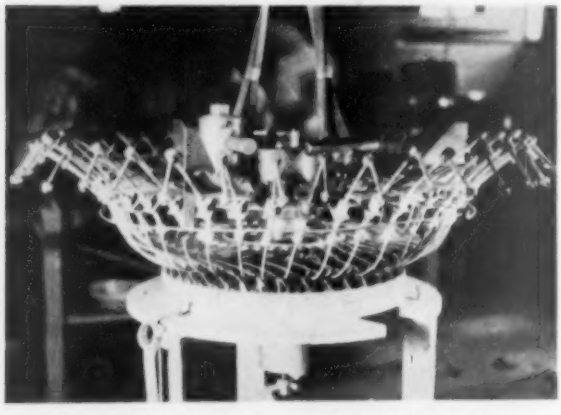


Fig. 9 Rotor holding fixture with spring-loaded fingers in position

Table 1—Basic Operations and Time Values

Operation	*Rotor, hr*	*Stator, hr*
(A) Preheat	0.046	...
(B) Heat to braze	0.063	0.046
(C) Braze (brazing alloy flow)	0.019	0.020
(D) Cooling period	0.020	0.062
(E) Remove pin fixture	0.022	...
(F) Remove complete assembly and accessories (boots, clamps, etc)	0.027	0.020
(G) Cool fixture (water bath and blow-off)	0.003	0.019
TOTAL	0.200 hr or 12 min	0.167 hr or 10 min

looking at the stator brazing fixture that there are four flame tips covering the outer ring compared to only one on the inner ring (see Fig. 14). This is to compensate for the greater surface speed and heat loss at the outer ring. In other words, both surfaces are brought to brazing temperature simultaneously.

This now brings us to the actual brazing operations. Table 1 shows the basic operations and time values, and illustrates that both are very similar.

With reference to the operations listed in Table 1, the following must be noted:

(A) In the rotor brazing process it was necessary to insert a preheat operation to insure that the flux was absolutely dry before brazing (see lead photograph). With reference to Figs. 5 and 11, it may be pointed out that enough moisture had to remain in the flux so that it could be spread and at the same time adhere to the surface at the time of application.

(B) Bringing the hub of the rotor up to brazing

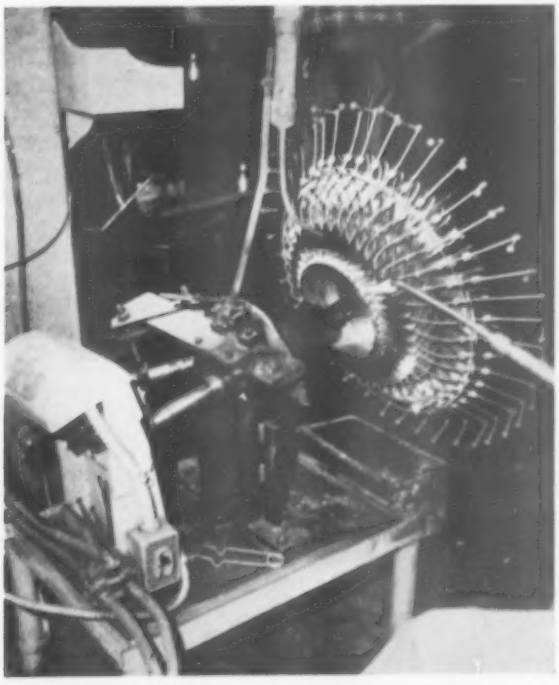


Fig. 10 Complete rotor rotating fixture showing bracing alloy feed hopper, drive and rotor holding fixture

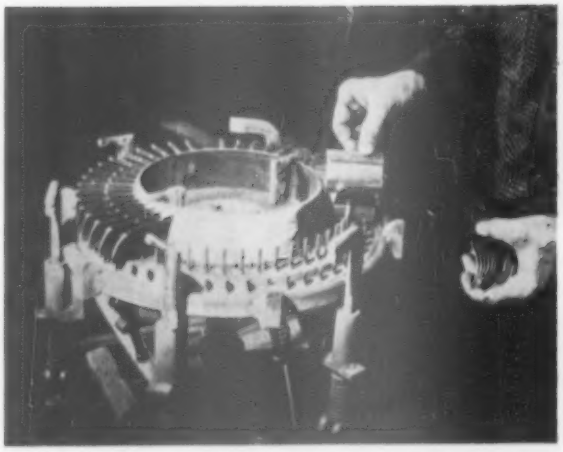


Fig. 11 Stator setup fixture with inner ring in place and blades being assembled

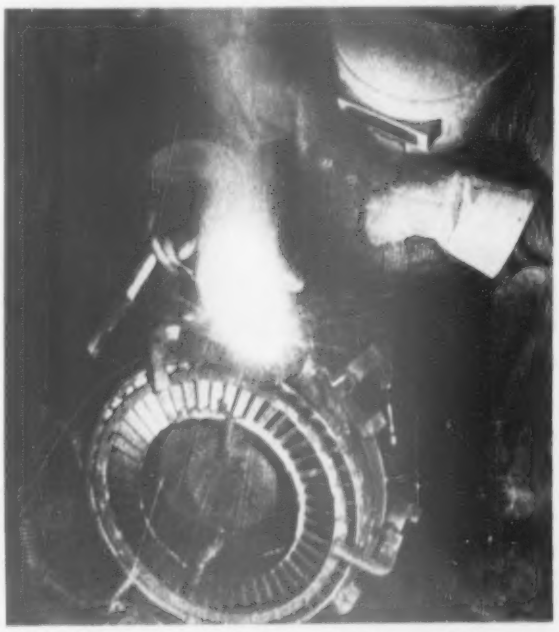


Fig. 12 Arc welding outer ring of stator assembly

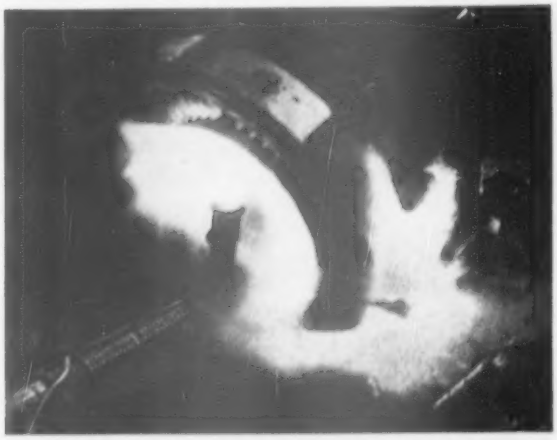


Fig. 13 Torches in position on stator brazing fixture

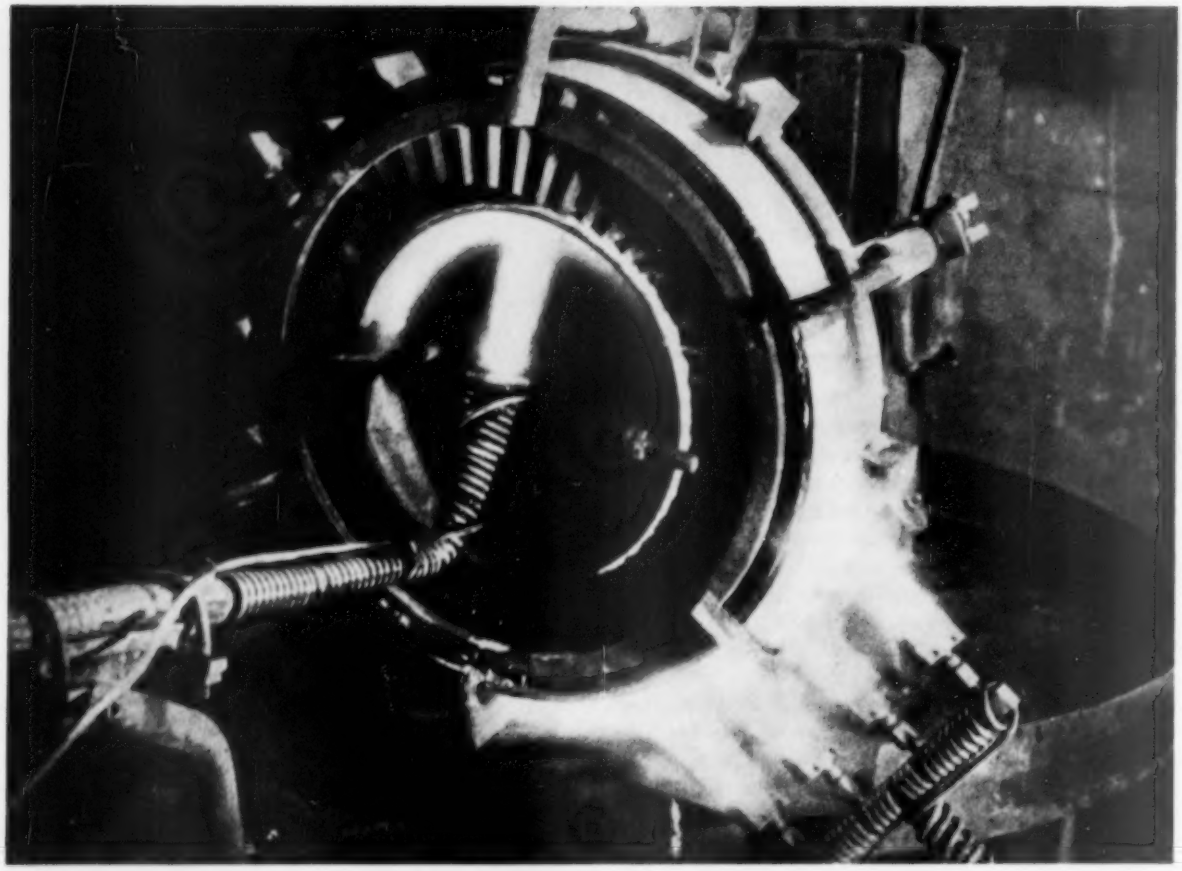


Fig. 14 Four flame tips cover the outer ring and only one covers the inner ring

temperature required more time because of the greater thickness of material than that of the stator.

(C) When the hub and rings are up to brazing temperature (approximately 1250° F), silver brazing alloy is fed to the centers of the blades by means of feed hopper and tube assemblies (see Fig. 15). The brazing alloy is caught by the smooth viscous flux and evenly distributed to the faying surfaces. A 45–40 mesh silver brazing alloy gave us the best results, with a shear strength of approximately 35,000 psi. The actual brazing time or brazing alloy flow required slightly more than a minute. The rotating fixtures turned about 2 rpm which allowed for an overlap to insure a good and uniform coverage of brazing alloy. The orifices in the lower section of the feed hoppers were of fixed size to produce an even flow in the above time. The rotor required 2.6 oz or 76 g of brazing material. The outside ring of the stator required 2.48 oz and the inside ring 1.77 oz, or a total of 4.25 oz or 120 g.

(D) The cooling period was an interval of time in which the assemblies were rotated on the fixtures with the heat turned off so the brazing material could set and solidify.

(E, F, G) The finished weld assemblies are removed from the fixtures and the fixtures are then prepared for the next setup (see Fig. 16).

A number of silver brazing methods were tried and abandoned in favor of the process just described. The first attempt was to apply silver brazing material in wire form bent around the root of the blades where they joined the hub and rings. This method was abandoned because the wires shifted position at the lower side on the rotating fixtures and also caused the blades to change position. Assembly of the formed wire required excessive manual work and time.

The next attempt was to place thin sheets of brazing material under the blades. This proved unsatisfactory because heat buckled these sheets and the blades shifted unpredictably. Considerable difficulty was encountered in holding the sheet solder in position and manual cutting and forming costs were prohibitive.

The third method tried was that of sifting powdered silver brazing material over the wet flux which had previously been applied to the hub or rings. Still another

Table 2—Comparison of Manual Operation and Mechanized Process

	Hand method	*Machine*	*Saving, %*
Brazing time, rotor	1 hr, 18 min	12 min	85
Brazing time, stator	1 hr, 15 min	10 min	87
Brazing alloy, rotor	8 oz	2.6 oz	68
Brazing alloy, stator	10.75 oz	4.25 oz	60

process was that of mixing powdered solder with flux and the resultant mixture spread on the rotor hub and stator rings. Both of these methods failed because, after heat had been applied, the moisture formed steam which caused the flux mixture to fall away from the surfaces to be brazed with a resultant poor brazed job.

Conclusion

The savings and benefits of the mechanized process are clearly shown in Table 2.

It should be kept in mind that the figures in Table 2 are for machine time only; that fact is most important as we are interested in what the mechanized method actually saves. Even injecting the time required for setup, there would still be effected a saving of 60% over the hand method. However, being interested primarily in what the machine accomplishes, we could then provide several set-up stations and operate the machine full time. In other words, one man operating the machine could braze from 35 to 40 assemblies in an 8-hr day or five times as many as the person performing the operation by hand.

Considering dollar value only of brazing alloy saved by the machine method and using 35 assemblies as a base, the results are almost unbelievable. The resultant saving is $129.50 for the rotors or $3.70 each and $143.50 for the stators or $4.10 each.

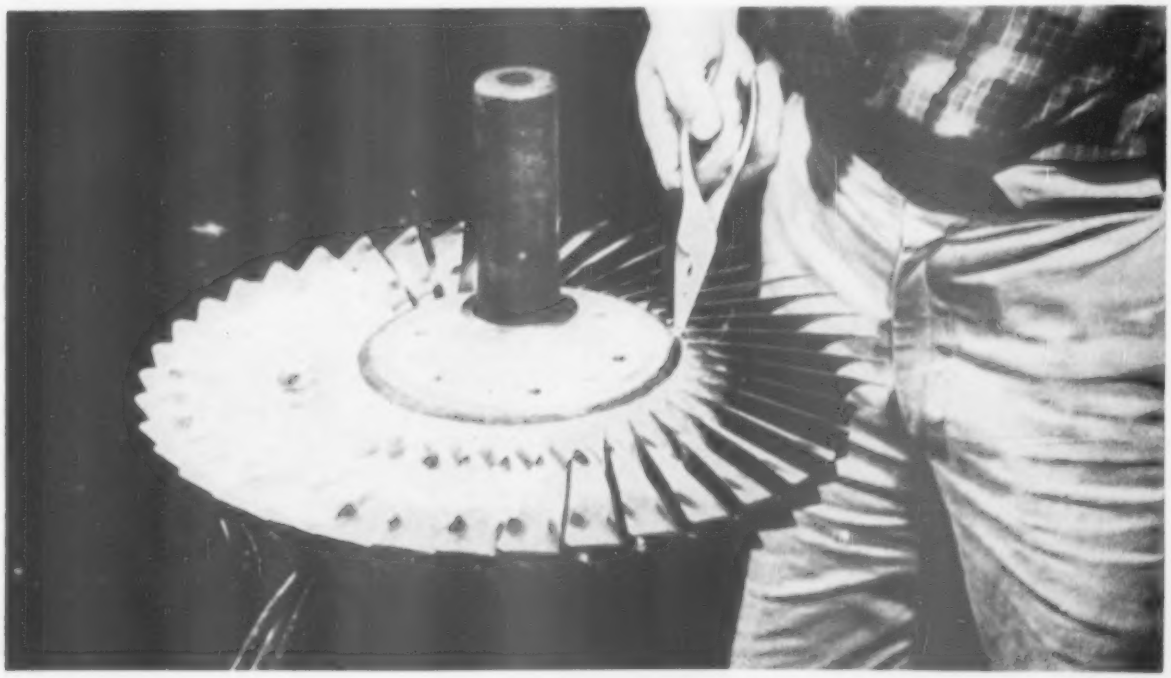
Comparing the quality of product of the two methods, the mechanized method is far superior. The smooth more uniform weld and small, well-formed fillets obtained are much better adapted to the high velocity air flow required. In addition, the mechanized method reduced the scrap loss in brazing to less than $\frac{1}{2}$ of 1%.

Fig. 15 Silver brazing alloy being fed to the centers of the blades by two feed hopper and tube assemblies

Acknowledgment

The author expresses his appreciation to James G. Sawyer, of the Sawyer Baily Corp., for having done so much to bring this project to a successful culmination, and to Russell Strate, of Strate Welding Supply Co., Inc., Buffalo, N. Y., for his assistance in the application of materials and equipment.

Fig. 16 Finished weld assembly



CHARACTERISTICS OF A RECTIFIER-TYPE CONSTANT-VOLTAGE POWER SUPPLY

Rectifier-type constant-voltage welding machines have been in service for several years with very good performance records

BY J. W. POMAZAL

ABSTRACT. This paper describes the principle of operation, and the characteristics of a rectifier-type constant-voltage direct-current power supply of the type being used in multiple-operator welding installations.

This power supply uses a main power transformer in conjunction with a special regulating magnetic circuit to provide an output voltage which remains constant over a wide range of output current.

Constant voltage is achieved by feeding back into the regulating circuit to produce the same compounding effects as are obtainable through the use of a series coil in a compound wound generator, the important difference being the elimination of rotating parts.

This paper describes the arrangement and functions of the cores and coils in the regulating circuit, and includes test data showing the characteristics of a single unit as well as the equal load distribution obtained when several units are operated in parallel.

Introduction

As a result of the wide acceptance and successful operation of rectifier-type machines by the welding industry, users of constant-voltage multiple-operator systems have also seen the possibilities of a nonrotating power supply for their installations.

Fig. 1 Constant voltage 500-amp, 70-v direct-current power supply

The principal advantages of the nonrotating power supply are the reduced idle losses, elimination of moving parts, and the ease of adding additional "packages" to give greater flexibility in the use of equipment.

Multiple operator systems consist of one or more sources of constant voltage (70–75 v) connected to heavy busses running to the welding area where each operator has a variable resistor bank to permit selecting the desired amount of welding current.

In order that the welding current for a given operator is not upset as additional operators start or stop welding, a relatively constant bus voltage is desirable throughout the entire system. Proper machine characteristics and adequate bus bar capacity make this possible.

General Description

Basically, a nonrotating d-c power supply requires a transformer to change from line voltage to open-circuit voltage, a rectifier bank to change the ac to dc, and a regulating circuit to compensate for voltage drop in the transformer and rectifiers.

Figure 1 shows a 500-amp rectifier-type constant-voltage power supply which is being used in several shipyards to replace constant-voltage motor generator sets.

In order to understand the operating characteristics of this power supply, the following inherent characteristics of the circuit elements must be kept in mind:

(*a*) Main Transformer: All transformers have an inherent voltage regulation; that is, the voltage drops slightly as load is applied. Within the working range,

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this drop can be considered as linear with respect to the load current.

(*b*) Rectifiers: The voltage drop in a selenium rectifier is not linear with respect to the load current. An inspection of the characteristics of a selenium rectifier stack will show that the regulation curve is rather steep at low values of current but tends to flatten at higher values of current.

(*c*) Premagnetized Iron Cores: The superimposing of a unidirectional flux on a magnetic core which is also being excited by alternating current affects the permeability and therefore affects the impedance of any winding in that magnetic circuit. Also, if another magnetic path is available, a corresponding portion of the flux will be diverted to the path with the greater permeability.

Principle of Operation

With these characteristics in mind, refer to Fig. 2 which shows the core and coil arrangement of the transformer and regulating circuit.

The main three-phase transformer which is shown on a conventional three-phase core is in the background and the six cores of the regulating circuit are in the foreground. These parts are mounted directly to a steel base thus giving a low center of gravity for greater stability.

The regulating circuit does not use a conventional magnetic structure. It consists of six U-shaped cores and I-shaped yokes arranged in three adjacent pairs; each pair representing one phase of a three-phase system. Two like secondary coils per phase are assembled on adjacent legs and a primary coil encircles these two secondary coils.

The main transformer secondary is designed for a phase voltage of approximately 57 v while the cumulative and differential secondary coils of the regulating circuit have a no-load voltage of approximately 10 v.

Figure 3 is a schematic diagram showing the elec-

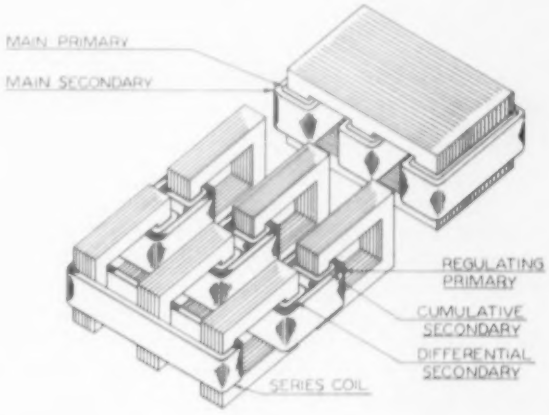
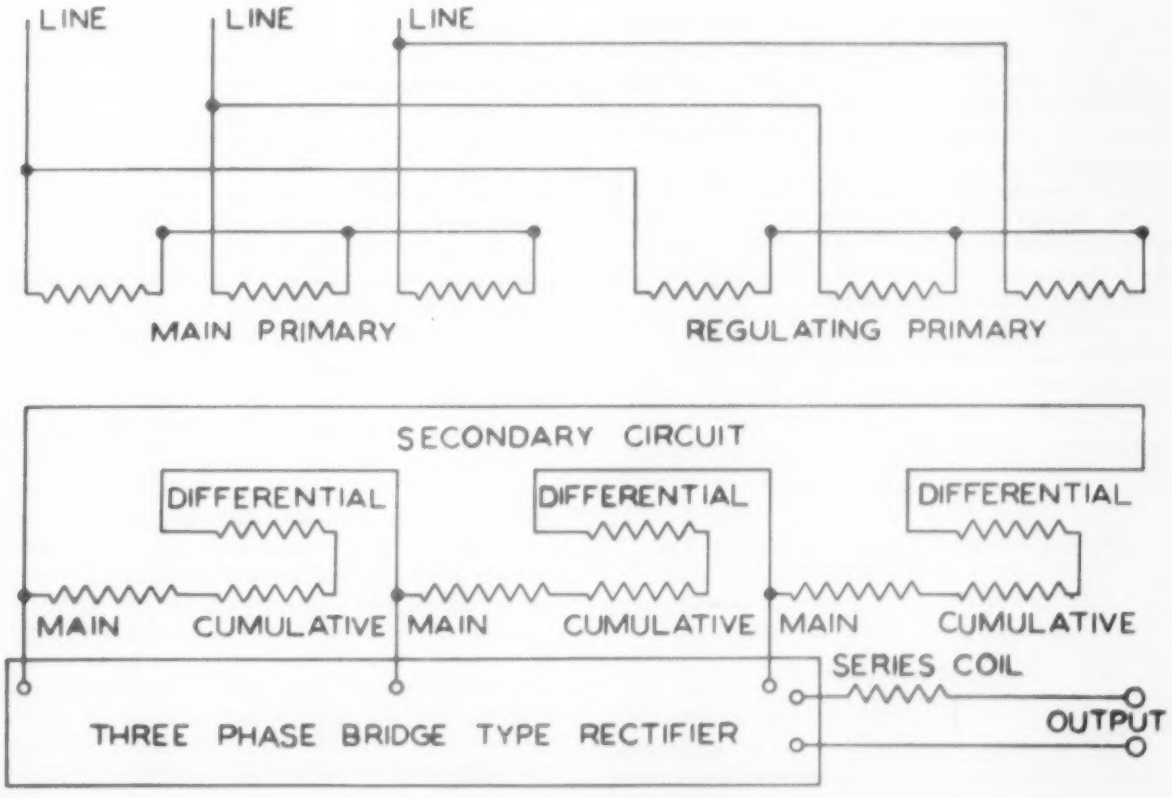


Fig. 2 Core and coil arrangement of transformer and regulating circuit

Fig. 3 Schematic wiring diagram



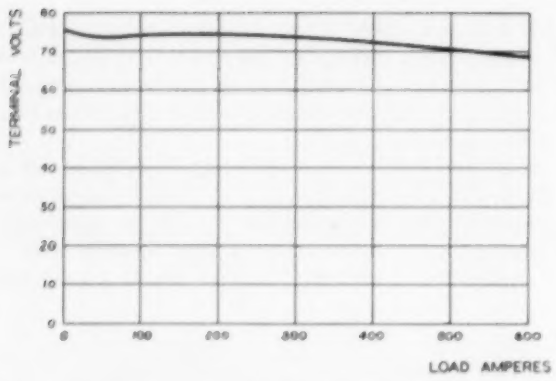


Fig. 4 Volt-ampere curve of 500-amp 70-v constant voltage power supply

trical connections between the various parts of this assembly. The star-connected primary of the main transformer is shown paralleled with that of the regulating circuit.

When the primary of the regulating circuit is energized and the secondary leads are open, the voltages induced in the secondary coils will be in proportion to their turn ratio because the flux will divide evenly between the two cores.

The two regulating secondary coils are connected in series but at opposite polarity so that the net voltage appearing at the ends of the regulating secondary circuit at no load will be zero.

Each of these coil combinations is connected in series with the corresponding main transformer secondary to form one phase of a closed delta. The 57-v main secondary is aided by the cumulative regulating secondary but this addition is offset by a similar differential regulating secondary and the net result at no load is still 57 v.

A three-phase bridge-type rectifier bank is connected to the corners of this delta secondary circuit. With 57 v impressed on a three-phase rectifier, the no-load d-c voltage is approximately 76 v. This represents the open-circuit voltage of the machine.

A series coil carrying the rectified d-c load current interlinks one core of each phase of the regulating circuit, the core which is interlinked being the core which also carries the differential secondary coil.

When load current is drawn from this machine, there is a voltage drop in the transformers and also in the rectifiers. This would result in a drop in the output voltage; however, this load current passes through the series coil and magnetizes the cores with the differential windings.

The total flux produced by the regulating circuit primary has two parallel magnetic paths. When the core in the differential portion is premagnetized, part of the flux of the regulating circuit seeks the path with the higher permeability and shifts from this differential core to the cumulative core. This reduces the differential voltage and increases the cumulative voltage, the result being an increase in the net regulating voltage. This voltage, when added to the main secondary voltage, raises the rectifier input voltage from 57 v to a value slightly higher, the amount of increase being sufficient to offset the drops and thereby give a flat voltage curve.

By selecting various values of cumulative and differential turns, series turns, and magnet core properties and proportions, it is possible to obtain a choice of voltage characteristics. For a multiple-operator system, a flat or slightly drooping curve is desirable. This dictated a selection of turns and core sections which gave a volt-ampere curve as shown in Fig. 4. It will be seen that the voltage drops slightly at light load because of the regulation of the rectifiers but the booster circuit immediately corrects this condition and the voltage curve is substantially flat over the entire range.

Table 1—Division of Load Current Between Two Machines with Interconnected Series

Load amperes, total	*Load volts*	*Load current of each machine*	
		Machine No. 1	*Machine No. 2*
0	77	0	0
100	74	50	50
200	75	100	100
300	75	150	150
500	74	255	245
600	73	310	290
750	72	375	375
900	71	450	450
1020	70	510	510

Parallel Operation

One characteristic of selenium rectifiers operating in parallel is a tendency for the hotter stack to carry more than its share of the load and thereby become even hotter until it might be damaged. When operating two or more machines in parallel, this can be prevented by an interconnection whereby the series coil of one machine carries the load current from the other. Thus, momentary increases in load on one unit will strengthen the other and force it to pick up more load and all units in the paralleled installation will divide the load evenly.

Table 1 shows the equal division of load current between two similar machines operating in parallel with interconnected series coils.

Conclusion

A number of these 500-amp machines have been in service for several years with very good performance records. Combinations of these units in groups of two or three assembled in a single enclosure have been made for locations where load conditions are predictable, whereas separate machines are sometimes preferred where load conditions vary greatly.

The largest machine built to date, which has a 100% duty cycle rating of 1500 amp at 75 v, indicates a trend toward this type of power supply for shipyard use. Experience gained over the past few years justifies a conversion to this type of power supply whenever existing motor generator sets are replaced.

Girth weld being made experimentally on light gage material at a speed of 150 ipm

THE CARBON-DIOXIDE-SHIELDED METAL-ARC WELDING PROCESS

High potential for welding cost reduction and excellent weld metal quality are the advantages claimed for this new process

BY R. J. KELLER AND J. KOSS

Introduction

The carbon-dioxide-shielded metal-arc welding process which is attracting a great deal of attention in recent months, appears to be one of the most significant developments in welding in the past several years. The importance of this process is emphasized by some of its advantages. First, the process has a high potential for welding cost reduction; second, it produces excellent weld metal quality; third, it is an automatic welding process with a visible arc; fourth, the process does not require flux for arc protection, thus eliminating slag removal problems after welding.

This paper will summarize the work done by the A. O. Smith Corp. on the development and use of the carbon-dioxide-shielded metal-arc process, and discuss the following items:

1. Equipment required for this process.
2. Comparison with other welding processes.
3. Requirements for successful application of this process.
4. Mechanical properties of the weld metal.
5. Metallurgical and chemical investigation of the weld metal.
6. Investigation of new applications for this process.

Equipment

The equipment necessary for use with the carbon-

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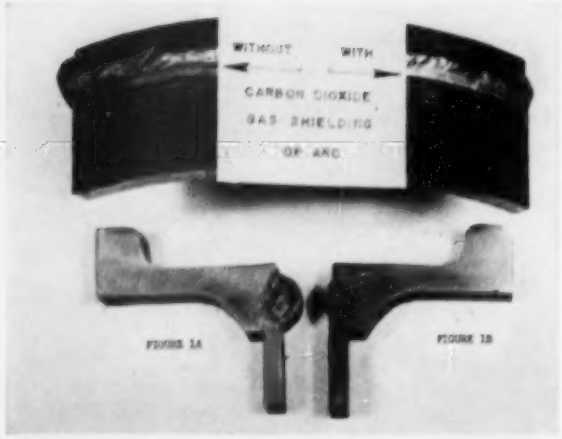


Fig. 1 Macro specimens of welds made with and without carbon dioxide gas shielding, showing the effectiveness of carbon dioxide as a shielding medium

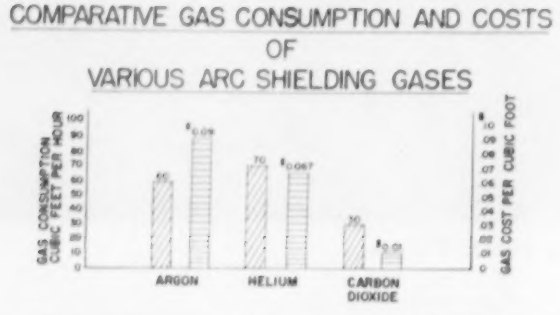


Fig. 2 Less gas consumption and extremely low cost gas, as shown in this chart, indicate the potential savings possible with the use of the carbon-dioxide-shielded metal-arc welding process

dioxide welding process is similar to equipment used with the shielded-inert-gas metal-arc processes. It requires a welding power supply unit which will provide adequate and reliable welding current, an automatic welding head to feed the wire to the work, an electrical control unit to control the automatic welding head, and a nozzle which provides a means of surrounding the welding puddle with carbon dioxide gas, as well as provide an electrical contact to the wire for the welding current.

When using the carbon-dioxide-shielded metal-arc welding process, it is important to consider the design of the welding head and nozzle. The welding head must be of such design as to provide higher wire feed speeds and still maintain good control of the welding arc. The nozzle design is also of prime importance, because proper shielding of the molten puddle is necessary in order to insure quality welds.

An example of inadequate shielding is shown in Fig. 1, which shows two welds made under identical conditions as to material, amperage, voltage, wire and travel speed. The only difference in making the welds shown, is that in Fig. 1*A* the carbon dioxide shielding gas was turned completely off. The weld, while smooth from the outside, was extremely porous, as shown in this macro. Figure 1*B* shows a weld made with identical welding conditions, having the proper shielding of carbon dioxide gas which produces a sound, strong and ductile weld. These examples show the effect of carbon dioxide shielding, and illustrate why nozzle design is of prime importance. From the difference in quality, where no shielding is used, it is easy to visualize the effect of improper shielding on porosity, which might occur if poorly designed nozzles were used.

Comparison with Other Welding Processes

The first question which arises concerning any new welding process is "What are its advantages over the existing welding processes which are currently in use?" In an effort to evaluate the carbon-dioxide metal-arc welding process, studies were made comparing the economics and quality of this process with the shielded-inert-gas metal-arc process, manual electrode welding, and submerged arc welding. Since the carbon-dioxide metal-arc process is similar to the other gas metal-arc processes with consumable electrode, let us first compare the cost and quality of welds made with the use of three industrial shielding gases, namely carbon dioxide, argon and helium.

Gas Costs and Consumption Rates

As shown in Fig. 2, it is obvious that with the cost ratio of 9 : 1 for argon and 7 : 1 for helium, as compared to carbon dioxide when purchased in cylinders, substantial savings can be realized on gas cost alone. For large consumers who can justify the purchase of carbon dioxide in tank truck quantities, the price can be further reduced by approximately 50%, thus affording still greater savings. As illustrated in Fig. 2, the gas consumption of carbon dioxide is approximately 50% that of argon or helium. Thus, when considering the consumption rates and gas costs, the savings which can be realized by using carbon dioxide for shielding are a significant amount, as illustrated in the following comparisons.

Carbon Dioxide Versus Helium

With these economic factors in mind, work was started several years ago to apply the use of carbon

Table 1—Comparative Cost of Helium and Carbon Dioxide

	Helium	*Carbon dioxide*	*Savings per head*
1. Gas consumption, cfh	70	30	40
2. Cost of gas per cu ft	$0.067	$0.01	$0.057
3. Cost of gas per hr	$4.69	$0.30	$4.39
4. Cost per hr (60% duty cycle)	$2.81	$0.18	$2.63
5. Cost per day (3 shifts—22.5 hr)	$63.20	$4.05	$59.15
6. Cost per year (260 days—3 shifts per day)	$16,420.00	$1,053.00	$15,367.00

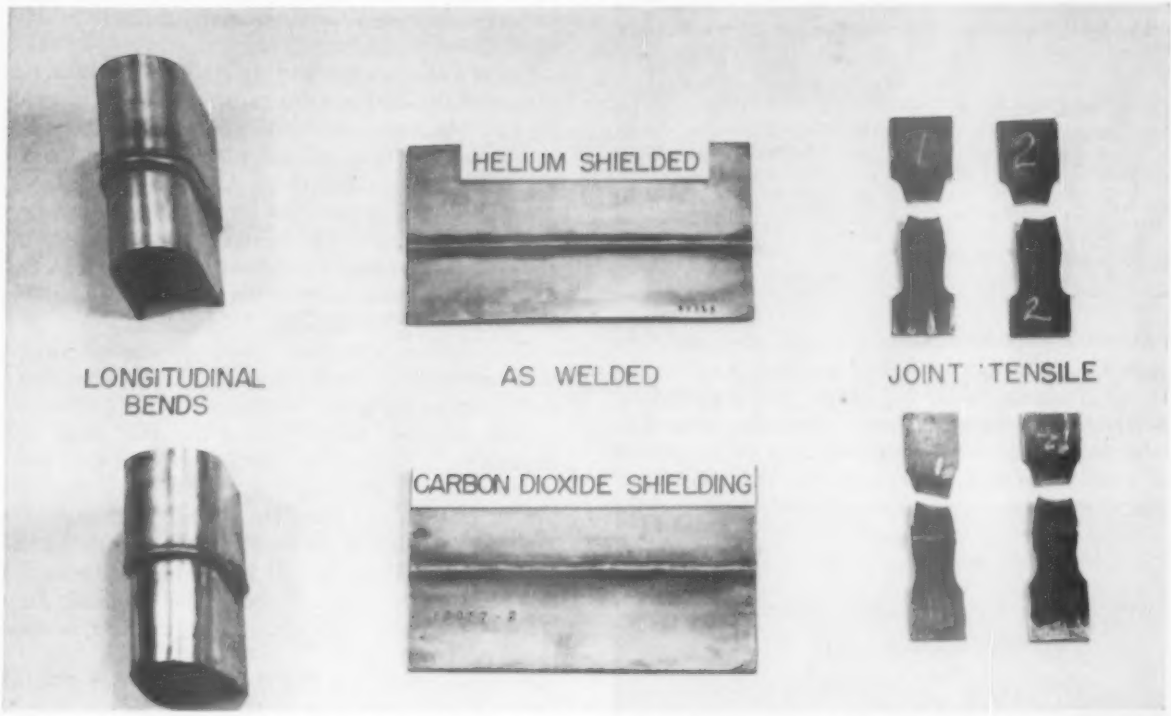


Fig. 3 Mechanical tests of high-speed lap welds made with carbon dioxide and helium, showing that both are satisfactory for this application

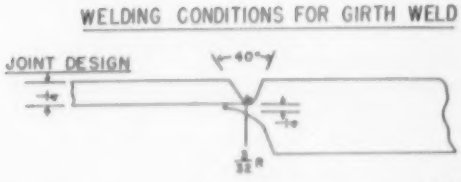
dioxide to the gas-shielded metal-arc process. The first production application to which the carbon dioxide process was applied consisted of a lap weld in light gage material. Requirements were for a strong and ductile weld which had to be made at high speed, and require only visual inspection. Table 1 shows the economics of using carbon dioxide, as compared to helium gas, for this application. On high production work where a number of heads might be involved, the total savings could be of considerable magnitude. It is readily apparent that the savings could amount to approximately $15,000 per year per head.

A thorough study of the quality of these welds was made, and as shown in Fig. 3, both welds had adequate strength and ductility and were entirely satisfactory for the application. Because of the possible savings, it is easy to understand why carbon dioxide was selected for the shielding gas.

The submerged-arc welding process was also considered for this application. However, because of the high degree of automation of jigs and fixtures with many moving parts, it was felt that the presence of submerged arc welding flux would add greatly to maintenance costs of the jigs and fixtures.

Carbon Dioxide Versus Argon

Recently a cost comparison on a production job was made in which a circumferential seam had to be welded. This particular joint involved the joining of a killed steel forging to a $^1/_4$-in. thick $9^5/_8$-in. diam shell of semikilled steel. This particular job required 100% penetration of the joint, and had to meet Class I ASME Boiler Code radiographic standards, as well as to be subjected to magnetic particle inspection.



	CO_2	ARGON
TYPE WIRE	1/16" SI. KILLED	1/16" SI. KILLED
AMPERES	425	400
VOLTS	30	24
TRAVEL SPEED	22"/MIN.	22"/MIN.
GAS CONSUMPTION	30 CU. FT./HR.	60 CU. FT./HR.

Fig. 4 Welding conditions used for comparing the effect of carbon dioxide and argon when joining a killed steel forging to a semikilled pipe

It was also necessary to deposit weld metal which would give a minimum yield strength of 70,000 psi. For this particular application, carbon dioxide and argon were the two shielding gases considered. Figure 4 shows the welding conditions and type of joint design which were used in this application. The welding conditions are quite similar, with the exception of gas consumption and lower arc voltage when using argon gas. Table 2 shows the results of the economic study made. Using 60 cfh of argon compared to 30 cfh of carbon dioxide, and taking into consideration the cost per cubic

Table 2—Comparative Costs of Argon and Carbon Dioxide

		Argon	*Carbon dioxide*	*Savings per head*
1.	Gas consumption, cfh	60	30	30
2.	Cost of gas per cu ft	$0.09	$0.01	$0.08
3.	Cost of gas per hr	$5.40	$0.30	$5.10
4.	Cost per hr (50% duty cycle)	$2.70	$0.15	$2.55
5.	Cost per day (3 shifts—22.5 hr)	$60.80	$3.38	$57.42
6.	Cost per yr (260 days—3 shifts per day)	$15,780.00	$878.00	$14,902.00

foot of the respective gases, on a high production job operating three shifts 260 days per year, a saving potential of approximately $15,000 per year is possible.

While the economics were extremely attractive, other factors had to be considered from the standpoint of quality. Would the radiographs be satisfactory? Would complete penetration be obtained? Would the strength be adequate? All of these factors had to be considered before adopting the carbon-dioxide-shielded metal-arc process which offered such excellent opportunities for lower welding costs.

Fig. 5 Typical radiographs of girth weld made using carbon dioxide shielding gas, denoting soundness of weld metal

Figure 5 shows a typical radiograph of a weld on this particular application, using carbon dioxide as a shielding gas. As can be seen in this photograph, the radiograph was free from defects and well within Class I Radiographic Standards of the ASME Boiler Code.

As it was necessary to meet a minimum yield strength of 70,000 psi, joint tensile specimens were prepared with and without the weld reinforcement, as shown in Fig. 6, and all specimens failed in the stock at a value above the required minimum yield.

Hounsfield all-weld metal tensile specimens were also made, as shown in Fig. 7, which also shows values above the 70,000 psi minimum required yield (0.2% offset).

Since complete penetration of the weld metal was imperative, numerous cross sections were cut from sample welds on this application and etched to determine if the penetration was adequate. Figure 8 illustrates a typical appearance of the welds made with carbon dioxide and also with argon. It is of interest to note the difference in the type of penetration obtained when using carbon dioxide gas as a shielding medium, as compared to that of argon.

It can readily be seen that the carbon-dioxide shielded weld has a well-rounded or broad type of penetration which while adequate in depth, provides an advantage in that there is less danger of missing the root of the weld, and also permits the gases to rise to the surface more easily, thus being less susceptible to gaseous porosity.

From our studies it is apparent that carbon-dioxide shielded welds adequately met the quality standards for this application, and it was therefore possible to take advantage of the economic savings in using the carbon-dioxide-shielded metal-arc welding process. This production application is operating satisfactorily at the present time.

Carbon Dioxide Versus Manual Electrodes

Since welding with coated electrodes is the most uni-

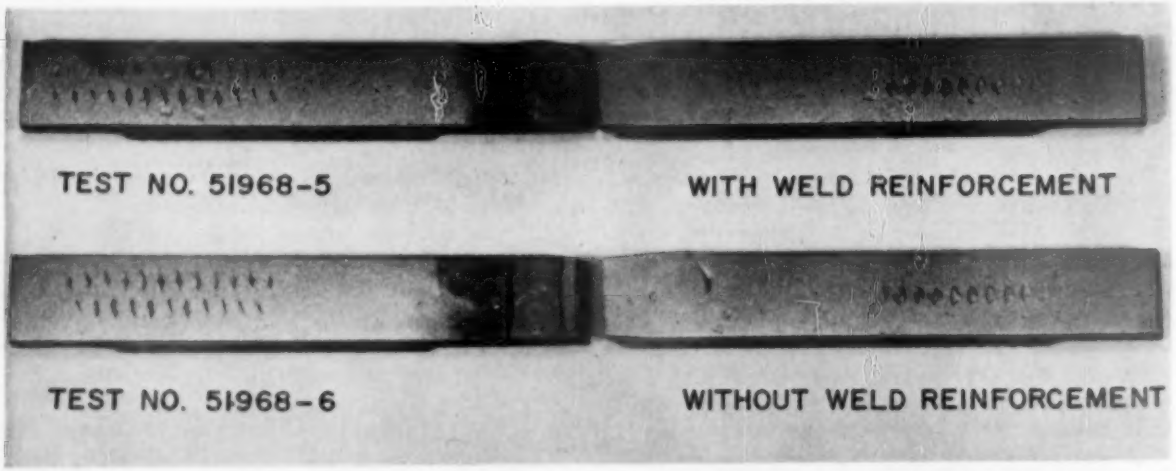


Fig. 6 Joint tensile specimens of welds made with carbon dioxide gas, demonstrating adequate strength with failure occurring in the stock

Table 3—Cost Comparison, Iron-Powder Electrodes vs. Carbon Dioxide 1/4-In. Fillet Welds 100 Ft Length (50% Duty Cycle)

		Iron powder	*Carbon dioxide*
1.	Cost of electrodes or filler wire	$3.55	$3.75
2.	Gas cost	...	$0.28
3.	Time required for 100 ft weld	3 hr 5 min	2 hr
4.	Labor at $2.20 per hr	$6.78	$4.40
5.	Plus burden (100%)	$6.78	$4.40
6.	Total cost	$17.11	$12.83

versally used process for mild and medium carbon steels, it is important that we compare the cost of manual welding with the carbon-dioxide-shielded metal-arc welding process. As the newly developed iron-powder electrodes have the highest deposition rate of manual electrodes, cost comparisons were made using this type of electrode. Table 3 gives the cost comparisons of making 100 ft of 1/4-in. fillet welds in A-285 steel, using an assumed 50% duty cycle. It is obvious from this study that considerable savings can be realized where the carbon-dioxide-shielded metal-arc process can be applied, in preference to manual welding. A practical limitation of fillet size in the horizontal position, using the carbon-dioxide-shielded metal-arc process, is approximately 1/4 to 5/16 in. Fillets larger than this tend to produce a weld of unequal leg lengths. For larger fillet welds it is necessary to position the work in order to obtain uniform cross sections.

Figure 9 shows a typical appearance and cross section of fillet welds made with E6024 iron-powder electrodes and the carbon dioxide process. It may be noted that there is much greater penetration with the carbon dioxide process when compared to that of the iron-powder electrodes, and while the surface appearance of the carbon-dioxide shielded fillet is good, it does not produce the extremely smooth ripples of the iron-powder electrode.

Carbon Dioxide Versus Submerged Arc Welding

An economic study was made comparing the carbon-dioxide-shielded metal-arc process with the submerged-arc welding process, as shown in Table 4. These studies were based on making a circumferential weld in a 14-in. diameter head to shell section. In addition to the savings shown, other advantages in using the

Table 4—Cost Comparison of High Speed Girth Weld Submerged Arc vs. Carbon Dioxide (Based on 100 Ft of Weld)

		Submerged arc	*Carbon dioxide*
1.	Gas cost	...	$0.03
2.	Flux cost	$0.525 (5.56 lb at $0.0945/lb)	...
3.	Wire cost	$0.555 (4.45 lb at $0.125/lb)	$0.96 (3.84 lb at 0.25/lb)
4.	Time per 100 ft weld	13 min	12 min
5.	Total cost of material	$1.08	$0.99

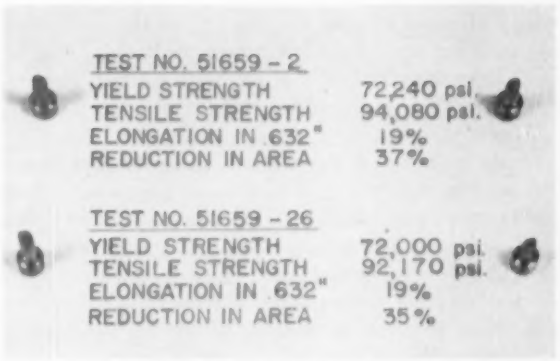

TEST NO. 51659 - 2
YIELD STRENGTH 72,240 psi.
TENSILE STRENGTH 94,080 psi.
ELONGATION IN 632" 19%
REDUCTION IN AREA 37%
TEST NO. 51659 - 26
YIELD STRENGTH 72,000 psi.
TENSILE STRENGTH 92,170 psi.
ELONGATION IN 632" 19%
REDUCTION IN AREA 35%

Fig. 7 All-weld metal tensile tests (made with carbon dioxide gas) in the as-welded condition, illustrating the mechanical properties that can be obtained with this process

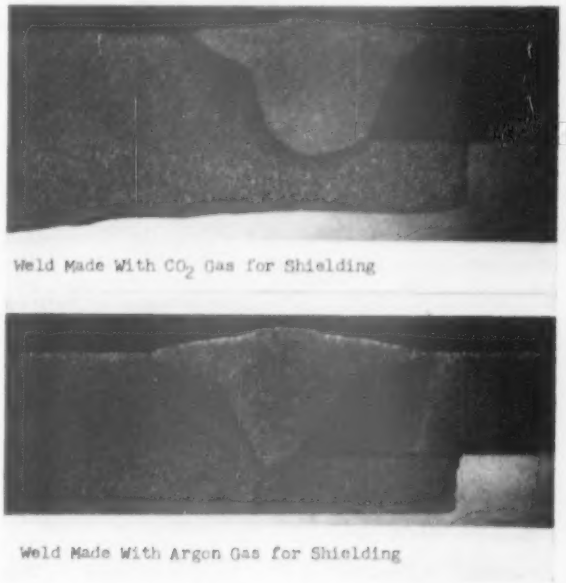


Fig. 8 Cross sections of weld made with carbon dioxide and argon gas, showing the typical appearance and penetration. Carbon dioxide shielding results in much broader type of penetration than that of argon

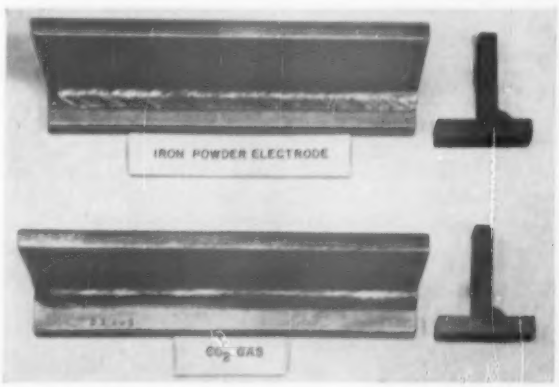


Fig. 9 Comparison of the penetration of the iron-powder electrodes and the carbon dioxide gas shielding

carbon-dioxide-shielded arc process are the absence of abrasive flux and slag, which cause considerable difficulty both from the standpoint of excessive wear on jigs and fixtures, as well as the added cost of removal.

While this particular application showed some advantage in the use of the carbon-dioxide-shielded metal-arc process, it is not implied that this same advantage exists on all applications. The submerged-arc welding process is a well-established one, and is extremely successful on many applications. Each application must be studied from a standpoint of economics before consideration is given to the use of the carbon-dioxide-shielded metal-arc process in its stead.

Requirements for Carbon-Dioxide-Shielded Metal-Arc Welding Process

With any new process, we can become very enthusiastic. While it is believed that the use of CO_2 as a shielding gas for welding mild and medium carbon steels has a great future, it should be pointed out that this process is not a cure-all or panacea for all welding problems. There are certain requirements which must be met if this process is to be used successfully.

Fitup

Like all automatic welding processes, the weld joint fitup requirements should be good, if high quality welds are to be obtained. While the carbon-dioxide-shielded metal-arc process is not any more critical than other automatic welding processes, fitup must be reasonably good if the process is to be successful.

Jigs and Fixtures

Adequate jigs and fixtures are required for the carbon-dioxide-shielded metal-arc process, the same as for any other automatic welding process. Many production jobs welded with automatic equipment are not successful, due to inadequate jigs and fixtures.

Steel Composition

When welding killed or semikilled steels, many commercially available wires developed for the shielded-inert-gas metal-arc process are satisfactory for use with the carbon-dioxide metal-arc process. However, when welding on rimmed steels, it may be necessary to adjust the wire composition in order to obtain sound welds.

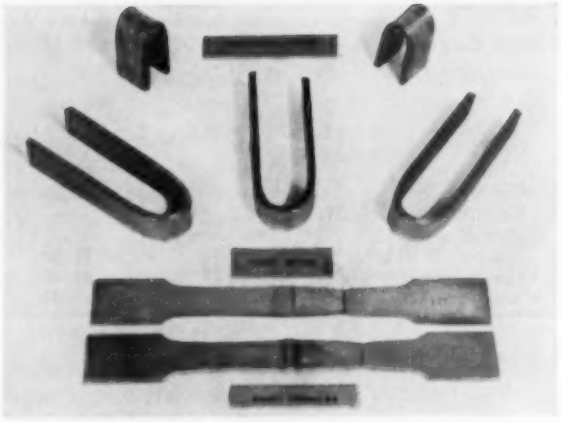


Fig. 10 Tested single-pass butt welds in A-285 stock show good strength and ductility

Position of Welding

Welding with the carbon-dioxide-shielded metal-arc process has been in most cases limited to welding in the downhand or flat position, although in several instances satisfactory welds were obtained when welding downhill at angles up to 60°. The process is readily adaptable to welding of circumferential seams, up to $^3/_8$-in. in thickness, depending on the diameter of the unit being welded.

Using this process, the welding arc may be located off-center to take advantage of a flooding or a cutting arc as desired, and still obtain satisfactory results.

Plate Thickness

Present requirements of the carbon-dioxide-shielded metal-arc process are confined to single-pass welds up to $^1/_2$-in. in thickness. However, recent work has indicated satisfactory results with two pass welds in stock up to $^5/_8$-in. in thickness. Laboratory work has included multi-pass welds in $^3/_4$-in. A-285 stock for 0.505-in. all-weld metal specimens, which we will discuss later in this paper.

Welding Procedure

As with all automatic welding processes, success de-

Table 5—All Weld Tensile Properties of Welds Made with Various Wires

0.505-In. Diam Specimens

Wire type	*Yield strength, psi*	*Tensile strength, psi*	*Elong. in 2 in., %*	*Red. of area, %*	*Remarks*
A	62,600	85,250	18.5	38.9	Silky, flake
	70,800	83,850	23.5	46.5	Silky, flake
B	64,800	81,850	27.5	57.4	Cup and cone, silky
	65,400	82,700	27.5	58.3	$^3/_4$ cup and cone, silky
C	82,900	93,150	19.0	34.5	Silky, flake
	81,500	93,300	17.0	29.1	Silky, flake

Hounsfield No. 12 Specimens

			Elong. in 0.832 in., %		
A	69,660	96,000	21.0	40.0	Shear, silky
B	62,635	88,270	25.0	37.0	$^1/_2$ cup and cone, silky

pends a great deal on the welding procedure, which after being worked out to give the desired quality of the weld must be rigidly enforced to give satisfactory production results.

In order to produce satisfactory welds with this process, high current densities are required. On most applications the current density will vary between 100,000 and 200,000 amp per square inch for satisfactory arc characteristics.

Economic Survey

In addition to the technical requirements, economic factors must also be considered. As in any automatic process, the first basic economic factor is that a large number of identical or similar items must be available for welding if the process is to be economically feasible. Each application must be studied to determine if the carbon-dioxide-shielded metal-arc process is applicable.

Mechanical Properties of Weld Metal

Mechanical properties of weld metal deposited with three types of wire, using the carbon-dioxide-shielded metal-arc process, as determined by all-weld tensile specimens, are shown in Table 5. The 0.505-in. all-weld tensile specimens were machined from multi-pass welds made in $^3/_4$-in. A-285 steel. Hounsfield # 12 all-weld tensile specimens were removed from single-pass production applications. You will note from the mechanical properties that these welds were satisfactory in all respects. Referring to the "B" composition in Table 5 the weld metal is certainly equal in all respects to that obtained from the test types of coated electrodes.

Figure 10 shows the results of tests made on a butt weld in $^1/_4$-in. A-285 steel, using the carbon-dioxide-shielded metal-arc process.

The longitudinal, root and face bend specimens denoted good ductility, penetration and side wall fusion. The joint tensile specimens, all of which failed in the base metal either with or without weld reinforcement left on, denote adequate strength.

Metallurgical Investigation

A series of metallurgical investigations were made on weld metal deposited with the carbon-dioxide-shielded metal-arc process, taken from various welds made both in production and the laboratory. This investigation revealed that the weld metal was free from nitride inclusions, as determined by heat treating the specimens to precipitate excess nitrogen in visible form. The study also revealed that the weld metal was clean and sound, free from segregations and oxide inclusions.

Metallurgical investigations were also conducted on welds made with argon and helium under similar circumstances, and the results were quite similar. From the metallurgical standpoint, no differences were detected between welds made with carbon dioxide, argon or helium.

Investigation of New Applications for This Welding Process

While we have presently set up as a requirement for the carbon-dioxide-shielded metal-arc welding process single-pass welds in relatively thin plate, recent work from the standpoint of equipment, wire composition and ever increasing knowledge of this process has permitted the successful welding of heavier gage materials by means of multi-pass welding.

Figure 11 shows the first step in this direction, in which double-pass butt welds were made in $^5/_8$-in. medium carbon steel, and mechanical properties from the standpoint of strength and ductility, were adequate for this application. More recent work has included using this process in the welding of low-alloy high-tensile

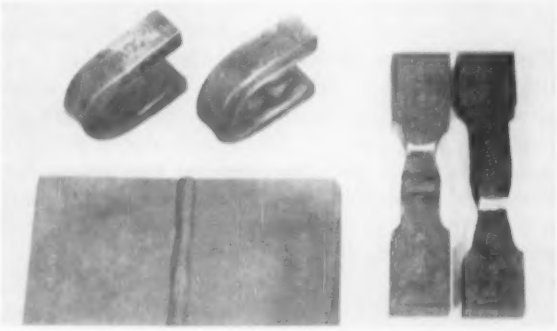


Fig. 11 Double-pass butt welds made in medium-carbon steel were satisfactory from the standpoint of appearance, side wall fusion, strength and ductility

steels, in the thicknesses up to $^3/_8$ in. Results to date are very encouraging and further work along this line is continuing. These particular applications have not been used in production, and at present are still in the laboratory stage.

On multi-pass welding of heavier gage material, it has been found beneficial to alter the groove design by reducing the root gap opening in order to obtain sound welds. Wire composition is also extremely important, and must be carefully selected for steel compositions being welded.

Conclusion

In the development of any new welding process, the range of application at the outset is usually limited. However, with continued research and use in production the range of application increases in scope and the process becomes widely used. At the present time there are a number of applications of the carbon-dioxide-shielded metal-arc process in production use. These applications have been proved economical and of good quality. We believe these applications indicate that the use of the carbon-dioxide-shielded metal-arc process will have considerable impact on the welding industry.

Recent publications have indicated that a number of companies are extremely interested in this process, and a great deal of research activity is going on industry-wise at the present time. With the emphasis of many people working toward a common goal, the use of carbon dioxide as a shielding gas in the welding industry is certain to be a success.

BUILDUP MADE EASIER BY GAS TUNGSTEN-ARC PROCESS

BY C. S. BEAVERS

The Birmingham Electric and Manufacturing Co., Birmingham, Ala.—specialists in industrial electrical machinery repair and machine work—uses the inert-gas tungsten-arc process with filler wire feeder to build up motor shafts. Like many users of the process for economical overlays on metals, this company finds it easy to pinpoint what they like best about the process—less work, cleaner operations and a better job at lower costs.

Take preparation—preparation cost is one-third that of older methods. When wire employed by the filler wire feeder unit builds up shafts, the only preparation necessary to do a good job involves taking a thin cut over the shaft surface to clean the metal removing oil deposits and then trueing up the shaft.

Also, since the amount of deposit metal required is better controlled, considerable time is saved in machining shafts at the finish.

C. S. **Beavers** is Technical Sales Representative, Birmingham District, Air Reduction Sales Co.

Another advantage is that less heat is transferred to the shaft; thus this company gets a better job along with the benefits of a fusion overlay instead of a mechanical bond. The setup for the welding operation is comparatively simple. The holder is mounted on the tool post of a lathe. The welding ground connection is made through four brushes contacting a ring which rotates with the part. A variable speed motor drives the lathe at speeds required for welding different size shafts.

The holder is connected to a high frequency unit for establishing the arc. On this operation $^1/_8$-in. diam. standard tungsten electrodes are used with $^3/_8$-in. gas nozzle; argon gas flow is 15 cfh with d-c straight polarity, 225 amp; filler wire is $^1/_{16}$-in. diam. mild steel.

Operating the lathe at 9 threads per minute, a buildup of $^1/_8$-in. on the diameter of $^1/_8$-in. on the side can be obtained on a 4-in. diam. shaft. In welding larger or smaller shafts, these figures change.

Fig. 1 Inert-gas tungsten arc in operation for motor shaft buildup at Birmingham

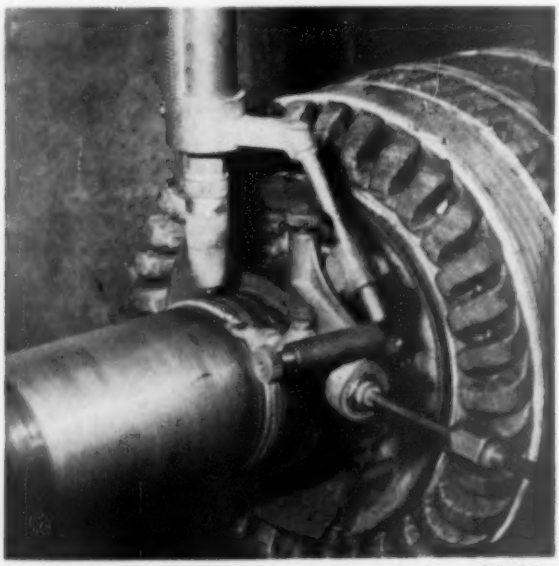


Fig. 2 Closeup shows weld deposit and view of holder and filler wire feeder

Society News

Fourth Welding Show Will Be Largest Ever Held —All Available Space for Displays Assigned

The fourth Welding Show, sponsored by the AMERICAN WELDING SOCIETY, will be staged in the Memorial Auditorium, Buffalo, N. Y., May 9 to 11.

The exposition will be the largest ever held in the industry. It will exceed by one-third the size of exhibits at the Kansas City show in 1955, and by 28 per cent, the record set when the show was last held in Buffalo in 1954.

All available space for displays has been assigned. Some one hundred companies will conduct exhibits. A total of 23,000 square feet of space has been assigned for exhibit booths. This compares with 17,500 in Kansas City, and 18,000 in Buffalo in 1954.

Extraordinary preparations are being taken to make the 1956 event the greatest in the society's history. Because of changes in the society's constitution, the annual business meetings are now held in the Spring and 1956 will witness the first time that an installation of officers will be held at the same time as the exposition.

The annual Spring Meeting, which will be held during the same week, May 7 to 11, also will introduce the many important innovations, announced last month. These will include the co-sponsorship of four technical sessions by the Metals Engineering Division of the American Society of Mechanical Engineers; the co-sponsorship by the Welding Committee of the Atomic Energy Commission of a session on the welding of nuclear reactor components, and the sponsorship of a session on the subject of safety, health and fire prevention by the AWS Technical Activities Committee. More than 60 papers, in 21 sessions are planned.

The Welding Conference, introduced successfully at Kansas City, will be conducted for the second time in Buffalo. It will feature discussions of the practical aspects of welding. Talks will be directed toward executives in industry who are not concerned principally with the latest developments in research but who wish to keep abreast of nontechnical aspects which improve production or maintenance techniques and reduce costs.

An educational lecture series intended principally for students in the engineering field is tentatively scheduled.

Among other major activities will be:

Plant tours of factories in the Niagara Frontier area: visitors will see at first hand late developments in welding as applied to actual production problems.

The President's Reception: this is the outstanding social event of the AWS year.

A National Dinner: this festive occasion will bring together hundreds of welding engineers, executives and AWS officers. A gala entertainment program will lend a gay note.

Ladies Entertainment: a full program of entertainment is planned for ladies who accompany visitors to the show and Spring Meeting. Visits to the famed Niagara Falls will be arranged not only for the ladies, but for all guests who wish to make the short trip. A visit to Canada will be included.

The annual meeting, as mentioned before, will be one of the highlights in Buffalo. Because 1955 witnessed the first time that the SOCIETY conducted its annual meeting in the Spring, it was voted to extend the term of all officers until the Spring of 1956. In May, all new officers will be installed. Other highlights will include the annual reports of President Humberstone and the summary of the past year's activities by Joseph G. Magrath, executive secretary.

Activities will be divided between the Memorial Auditorium and the Hotel Statler, they are located within easy walking distance of each other. The exposition, the welding conference and the educational lecture series will be held at the Auditorium, while the technical papers sessions, the annual meeting and the social events will be at the hotel.

Choice hotel reservations may be had only by making early application. They should be addressed to the SOCIETY's headquarters in New York. AWS Section members who wish to

AWS DIRECTORS-AT-LARGE

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add gaiety to their trip by traveling in a group should make early arrangements with railroads, airlines or busses for group accommodations.

California Student Chapter Hears Plummer

Fred L. Plummer, director of engineering at Hammond Iron Works, Warren, Pa., and past president of the AWS, addressed the AWS Student Chapter of California State Polytechnic College on November 16. The subject of his discussion was "Field Erected Storage Vessels."

A great deal of interest was shown in Mr. Plummer's discussion. The meeting did not break up until midnight and only then because Mr. Plummer had to catch a train.

PLUMMER ADDRESSES AWS STUDENT CHAPTER

Past-President "Fred" Plummer discussed pressure vessels at the November 16, 1955 meeting of student members at the California State Polytechnic College. Pictured here are *(left to right)*: Carl T. Schmid, chairman; Fred L. Plummer, John E. Bartley, secretary-treasurer; James H. Schield, vice-chairman; and Richard C. Wiley, Welding Department head

TAC TALKS

FILLER METALS—IV

Surfacing Filler Metal

by H. S. Avery

At a meeting of the Surfacing Filler Metal Subcommittee (Subcommittee VII of the AWS-ASTM Committee on Filler Metal) in August a new tentative specification for a group of surfacing filler metals was approved after many revisions. It has since been approved by the Main Filler Metal Committee. This is a culmination of about 4½ years' work. The specifications will be available in the spring of this year.

Ever since surfacing was industrially recognized as an important technique, outlining of specifications has been difficult because the alloys have been largely proprietary and the useful properties have not lent themselves well to engineering measurement. The present result still suffers from the second limitation but should aid both the producer and the user of surfacing filler metals.

Six important groups of filler metals: (1) high-speed steels, (2) austenitic manganese steels, (3) austenitic high chromium irons, (4) chrome-cobalt-tungsten (Stellite type) alloys, (5) nickel-chromium-boron-alloys and (6) a variety of copper base alloys (including aluminum bronzes) are covered by chemical composition ranges, standard sizes of welding rods and electrodes, packaging, physical quality details and informative appendices. In all, about 43 specific grades are defined.

There are many other groups of surfacing filler metals that are not yet covered. Subcommittee VII expects to add continually to the specification as rapidly as composition ranges can be sharply defined and matching technical data can be assembled for the correlated appendix. The criteria used to establish the groups for this initial draft were: (1) approximate industrial standardization; (2) covered only by expired patents, if they have been patented; (3) availability from more than one manufacturer, and (4) availability of a certain amount of information for the appendix.

A number of interested companies and individuals who received a preliminary draft have indicated that the appendix is the most useful part of the specification. For each classification of filler metal some information is provided about applications, hardness as welded, hot hardness, impact behavior, oxidation and corrosion resistance, abrasion resistance, metal-to-metal wear, properties under compression, machinability, identification criteria, metallography, heat treatment and welding characteristics. A bibliography is appended to show where sources may be consulted and further information obtained.

Within this framework the amount and quality of available information differs. The subcommittee was not satisfied with some of the items but voted to release the present form rather than delay for further improvements that could be added to later versions. This lack of generally accepted criteria of service performance and standards of weld deposit quality remains a problem.

H. S. Avery, Chairman, Subcommittee VII, A.W.S.-ASTM Committee on Filler Metal; Research Metallurgist, American Brake Shoe Co.

EMPLOYMENT SERVICE BULLETIN

Positions Vacant

There are immediate openings for engineers and scientists who can accept appointments as Patent Examiners. The salaries for Examiners start at $4345 a year, and it is possible to reach a salary of $7570 in five and one half years. The Patent Office also offers liberal vacations, sick leave and pension benefits.

Engineers and scientists holding a college degree in engineering or applied science, or a degree with a major in chemistry or physics, or with certain combined credits in these fields, are eligible for appointment as Patent Examiners, without examination, upon application to the Commissioner of Patents in Washington, D. C.

TECHNICAL PAPERS SESSIONS

1956

AWS NATIONAL SPRING MEETING and ASME METALS ENGINEERING DIVISION CONFERENCE

MAY 7-11 • HOTEL STATLER, BUFFALO, N. Y.

REGISTRATION

Mezzanine Lounge, Hotel Statler

Sunday, May 6
3:00 P.M. to 6:00 P.M.
Monday, May 7
8:00 A.M. to 4:00 P.M.
Tuesday, May 8
8:00 A.M. to 4:00 P.M.
Wednesday, May 9
8:30 A.M. to 4:00 P.M.
Thursday, May 10
8:30 A.M. to 3:00 P.M.
Friday, May 11
8:30 A.M. to 12:30 P.M.

MAY 7, MONDAY MORNING

Assembly Room—10:00 A.M.—Official Opening & Business Session

Address—*J. H. Humberstone, President, AWS*

Digest of the Technical Meeting Papers—*J. J. Chyle, 1st Vice-President, AWS*

European Welding Operation—Report and Open Discussion—*R. W. Clark, S. A. Greenberg and C. E. Jackson*

MAY 7, MONDAY AFTERNOON

Three Simultaneous Sessions

1. WELDABILITY AND RESEARCH

Empire State Room—2:00 P.M.

A. The Evaluation and Comparison of Weldability Tests on Armor Materials

by S. WEISS, J. RAMSEY and H. UDIN, Massachusetts Institute of Technology

B. Some Dynamic Properties of Heat-Treated Low-Alloy Weld Deposits (Ni-Mo-V 100XX)

by W. H. WOODING and E. H. FRANKS, Philadelphia Naval Shipyard

C. Impact Performance of Synthetically Reproduced Heat-Affected Zone Microstructures in T-1

by E. F. NIPPES, Rensselaer Polytechnic Institute, and C. R. SIELEY, Air Reduction Research Labs.

2. GAS-SHIELDED WELDING

New York Room—2:00 P.M.

A. Metal Transfer Characteristics in Gas-Shielded Arc Welding

by HOWARD C. LUDWIG, Westinghouse Research Labs.

B. Argon-Hydrogen Mixtures for Tungsten-Arc Welding

by E. F. GORMAN and T. McELRATH, Linde Air Products Co.

C. New Power Sources for Metal-Arc Gas-Shielded Welding

by A. U. WELCH, General Electric Co.

3. WELDED STRUCTURES

Delaware Room—2:00 P.M.

A. Welded Joint Design for Economy in Structural Fabrication and Erection

by OMER BLODGETT, Lincoln Electric Co.

B. Welded Top Plate Beam-Column Connections

by CYRIL D. JENSEN, Lehigh University, and R. FORD PRAY III, Syracuse University

C. A New Concept in Fabrication and Launching of Vehicular Tunnel Tubes

by F. P. IAPALUCCI, C. J. ASCENZI and S. W. GEARHART, Jr., Baldwin-Lima-Hamilton Corp.

MAY 8, TUESDAY MORNING

Three Simultaneous Sessions

4. NUCLEAR REACTOR COMPONENTS

New York Room—9:30 A.M.

Sponsored by Welding Committee of Atomic Energy Commission

A. Fabrication of Homogeneous Reactor Test Vessel Assembly

by L. F. BLEDSOE, F. V. DALY, Newport News Shipbuilding & Drydock Co., and G. E. ELDER, W. R. GALL, E. C. Miller, Union Carbide Nuclear Co.

B. Fusion Welding Zirconium for a Nuclear Reactor

by BRUCE L. BAIRD, North American Aviation, Inc.

C. Sodium Corrosion and Oxidation Resistance of High Temperature Brazing Alloys

by G. M. SLAUGHTER, E. E. HOFFMAN, C. F. LIETTEN, F. PATRIARCA, Oak Ridge National Lab.

5. WELDABILITY AND RESEARCH

Empire State Room—9:30 A.M.

A. Investigation of Weld-Metal Cracking in High-Strength Steel—Part II

by ARTHUR LOWE, Jr., RAEMAN P. SOPHER, PERRY J. RIEPPEL, Battelle Memorial Institute

B. A Weld Cracking Susceptibility Test for Sheet Materials

by J. S. BOUDREAU, General Electric Co.

C. Fracture Behavior in the Slow Notch-Bend Test

by WILLIAM J. MURPHY and R. D. STOUT, Lehigh University

6. RESISTANCE WELDING

Delaware Room—9:30 A.M.

A. Characteristics of Mash Seam Weld

by M. L. BEGEMAN and E. J. FUNK, University of Texas

B. Complete Spotweld Quality-Control by Examination of Torsion-Shear Fracture

by A. V. WENDLING and P. JOUMAT, Sciaky Bros.

C. Metal Gathering by the Resistance Heating Process

by W. F. HAESSLY, Taylor-Winfield Corp.

MAY 8, TUESDAY AFTERNOON

Three Simultaneous Sessions

7. WELDING OF DISSIMILAR METALS

New York Room—2:00 P.M.

Sponsored by the Metals Engineering Division of ASME

A. Development of a Ferritic-Austenitic Weld Joint for Steam Plant Application, and Simulated Service Tests

by F. EBERLE and J. T. TUCKER, Babcock and Wilcox Co.

B. Butt Welding Austenitic Stainless Steel to Ferritic Steel in Cylindrical Shapes

by J. E. DONAHUE, Westinghouse Electric Corp.

C. Carbon Migration in Welded Joints at Elevated Temperature and Its Effect on Certain Mechanical Properties

by ROBERT J. CHRISTOFFEL, ROBERT M. CURRAN and JOHN E. CORR, General Electric Co.

8. SAFETY, HEALTH AND FIRE PREVENTION

Empire State Room—2:00 P.M.

Sponsored by Technical Activities Committee

A. Health Aspects in Welding

by B. L. VOSBURGH, M.D., General Electric Co.

B. Safety in Installation and Use of Welding Equipment

by BENJAMIN F. POSTMAN, Employers Mutual of Wausau

C. Fire Prevention

by E. R. WALLACE, Eastman Kodak Company

D. A Plant Program for Plant Safety and Efficiency

(a) The Approach of General Motors

by ROBERT L. SNYDERS, General Motors Institute

(b) Organizing and Applying the Program

by LEON J. ROSE, Fisher Body Div., General Motors Corp.

9. WELDING ELECTRODES

Delaware Room—2:00 P.M.

A. New Iron Powder Electrodes and Their Application

by ROBERT SHUTT, Lincoln Electric Co.

B. Effect of Moisture in the Coating of Low-Hydrogen Iron-Powder Electrodes

by D. C. SMITH, W. G. RINEHART and K. P. JOHANNES, Harnischfeger Corp.

C. Development of Filler Wires for Welding SAE 4130, 4140, and 4340 Steels

by H. W. MISHLER, R. P. SOPHER and P. J. RIEPPEL, Battelle Memorial Institute

MAY 9, WEDNESDAY MORNING

Three Simultaneous Sessions

10. TYPE 347 STAINLESS STEEL

New York Room—9:30 A.M.

Sponsored by Metals Engineering Division of ASME

A. Time and Temperature Dependence of Welded Joint Properties
by J. HEUSCHKEL, Westinghouse Research Labs.

B. Time-Temperature Effect on Properties of Weld Heat-Affected Zone in Type 347 Stainless Steel
by E. F. NIPPES, Rensselaer Polytechnic Institute, W. L. FLEISCHMANN and R. L. MEHAN, General Electric Co., B. SCHAAF, Westinghouse Electric Corp.

C. Some Considerations in the Welding of Austenitic Chromium-Nickel Stainless Steels
by O. R. CARPENTER and R. D. WYLIE, Babcock and Wilcox Co.

11. PIPING AND TUBING

Empire State Room—9:30 A.M.

A. Arc Welding of 2¼% Cr-1% Mo Alloy Steel Pipe
by JAY BLAND, Standard Oil Co. (Indiana)

B. Joining Tubes to Tube Sheets for Corrosive Radioactive Chemical Service
by W. R. SMITH, General Electric Co.

C. Economics of Welding in Small, Non-Critical Piping
by HERSCHEL A. SOSNIN, Tube Turns, Inc.

12. BRAZING AND SOLDERING

Delaware Room—9:30 A.M.

A. Fatigue Strength of Silver Alloy Brazed Joints in Steel
by CHESTER H. CHATFIELD, Handy & Harman

B. Physical Properties of Commercial Silver Copper Phosphorus Alloys
by KARL M. WEIGERT, Curtiss-Wright Corp.

C. Principles and New Developments of Tin-Zinc Alloys for Soldering Aluminum
by ARTHUR S. LAURENSON, Belmont Smelting and Refining Works, Inc.

MAY 9, WEDNESDAY AFTERNOON

Three Simultaneous Sessions

13. TESTS OF WELDS

New York Room—2:00 P.M.

Sponsored by Metals Engineering Division of ASME

A. Correlation of Test Requirements and Characteristics of Welded Fabrication
by HELMUT THIELSCH, Grinnell Co.

B. Inspector's Interpretation of Results of Tests on Welds
by T. R. HARDIN, Hartford Steam Boiler Inspection & Insurance Co.

14. HIGH ALLOYS

Delaware Room—2:00 P.M.

A. Rupture Properties of Inconel Weldments at 1400, 1600 and 1800° F
by DONALD A. SCOTT, The International Nickel Co. of Canada, Ltd.

B. Nickel - Chromium - Iron Weldments—Through the Microscope
by HENRY JOSEPH ALBERT and FRANK SAUERSOPF, General Dynamics Corporation

C. Welding the Cupro-Nickels by the Inert-Gas-Shielded-Arc Processes
by LOWELL H. HAWTHORNE, Revere Copper and Brass, Inc.

15. WELDING AND CUTTING PROCESSES

Empire State Room—2:00 P.M.

A. Ultrasonic Welding
by J. BYRON JONES, Aeroprojects Inc., and JAMES J. POWERS, Jr., Pitman-Dunn Labs.

B. Tungsten-Arc Cutting of Aluminum
by R. L. O'BRIEN, G. W. OYLER and J. MAIER, III, Linde Air Products Co.

C. Comparison of Mechanical with Thermal Methods of Cutting Aluminum and Stainless Steel
by EDWARD H. ROPER, Air Reduction Sales Co.

MAY 10, THURSDAY MORNING

Three Simultaneous Sessions

16. HIGHER WORKING STRESSES

Empire State Room—9:30 A.M.

Sponsored by Metals Engineering Division of ASME

A. Balanced Pressure Vessel Design and Construction for Improved Economics
by D. ROSSHEIM, M. W. Kellogg Co.

B. Evaluation of the Significance of Charpy Tests for Quenched and Tempered Steels
by P. P. PUZAK and W. S. PELLINI, Naval Research Lab.

C. The Significance of Fatigue Data in Pressure Vessel Design
by T. J. DOLAN, University of Illinois

D. The Significance of the Tensile Test in Pressure Vessel Design
by W. E. COOPER, Knolls Atomic Power Lab., General Electric Co.

17. STAINLESS STEEL

Georgian Room—9:30 A.M.

A. Calculation of Ferrite Content of Stainless Steel Weld Metal
by W. T. DeLONG, G. A. OSTROM and E. R. SZUMACHOWSKI, McKay Co.

B. Root Passes in Stainless Steel with New Inert-Arc Procedure
by EUGENE B. LaVELLE, L. H. RASMUSSEN and E. M. KUCHERA, General Electric Co.

C. Stress-Corrosion Cracking of Type 304 Austenitic Stainless Steel
by HUGH L. LOGAN and RICHARD J. SHERMAN, Jr., National Bureau of Standards

18. APPLICATIONS

Delaware Room—9:30 A.M.

A. Application of Pressure Welding to the Aircraft Industry
by ARNOLD LAGE, Menasco Mfg. Co.

B. How to Reclaim Plant and Machinery by Practical Welding Applications
by GEORGE GORDON MUSTED, Welding Engineer & Consultant

C. Nondestructive Testing of Welds
by WARREN J. McGONNAGLE, Argonne National Lab.

MAY 11, FRIDAY MORNING

Three Simultaneous Sessions

19. ALUMINUM

New York Room—9:30 A.M.

A. Large Scale Aluminum Fabrications
by STANLEY I. ROBERTS and ORVILLE P. CARDINAL, San Francisco Naval Shipyard

B. Arc Welding of High Strength Aluminum in Heavy Sections
by WILLIS G. GROTH and R. A. MATUSZESKI, ACF Industries, Inc.

C. Properties of Arc-Welded Joints Between Aluminum and Stainless Steel
by M. A. MILLER and E. W. MASON, Aluminum Company of America

20. PRESSURE VESSELS

Empire State Room—9:30 A.M.

A. Unpredictable Behavior of Welded Pressure Vessels in Agricultural Ammonia Service
by THOMAS J. DAWSON, Ingalls Shipbuilding Corp.

B. Static and Fatigue Resistance of Welded Pressure Vessels
by DR. GEORGES WELTER, École Polytechnique

C. Multi - Power Submerged - Arc Welding of Pressure Vessels and Pipe
by R. A. KUBLI and W. B. SHARAV, Linde Air Products Co.

21. SURFACING

Delaware Room—9:30 A.M.

A. Automatic Hardfacing Saves Pipe and Catalyst
by R. F. ARNOLDY, Texas Alloy Products Co.

B. Welded Overlay Rotating Bands
by FRANK W. HUSSY and IRVING G. BETZ, Pitman-Dunn Laboratories, Frankfort Arsenal

C. Comparative Properties of Electrodes for Arc-Welding Austenitic Manganese Steel
by H. F. REID, Jr. and W. L. LUTES, McKay Co.

The above schedule of technical papers is not necessarily final. A more complete and detailed program, including an account of other activities, will be published in the* April *issue of THE WELDING JOURNAL.

WELDING SHOW EXHIBITS AND DEMONSTRATIONS

MEMORIAL AUDITORIUM

Hours of the Exposition

Wednesday, May 9
12:00 Noon to 10:00 P.M.
Thursday, May 10
10:00 A.M. to 10:00 P.M.
Friday, May 11
10:00 A.M. to 6:00 P.M.

Admission by Registration

8 reasons why production welding should be done with LINCOLN

IDEALARC

1. **Choice of AC or DC** welding current . . . whichever is best for your job. The ideal welder for production line operations.

2. **Dual control gives soft arc and forceful, non-sticking arc** . . . Idealarc gives you both, in AC and DC.

3. **Easy Striking** . . . Lincoln Arc Booster gives easy striking for both AC and DC to assure positive arc starting.

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5. **Dependable operation** under the heaviest loads... with complete overload protection against burnout.

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7. **Available as a straight AC welder** to which DC can be added at any time.

AND THE BEST REASON OF ALL

8. **LOWER COST PER WELD** through faster AC and DC welding with Lincoln's new iron-powder electrodes:

JETWELD 1 for welding flat and horizontal fillets.

JETWELD 2 for welding flat, deep grooves and horizontal fillets.

JETWELD 2HT for welding flat position, deep groove joints and fillets in low-alloy, high tensile steels.

"Improved" **FLEETWELD 47** for fast, smooth, all-position welding.

Hadn't you better check LINCOLN now?

Have Lincoln's factory-trained specialist show you how IDEALARC and these new Lincoln electrodes will give you better production, lower costs. Write for Bulletin 1343.

THE LINCOLN ELECTRIC COMPANY

Dept. 1912, Cleveland 17, Ohio

The World's Largest Manufacturer of Arc Welding Equipment

Section News and Events

as reported to Catherine O'Leary

HOME CONSTRUCTION

Fort Wayne, Ind.—John R. Worthman of John R. Worthman, Inc., home builders in Fort Wayne and surrounding area, was the speaker at the December 18th dinner meeting of the *Anthony Wayne* Section held at the Hobby Ranch House, where a delicious swiss steak dinner was enjoyed by 45 members.

Mr. Wayne gave a very good talk on homes and their construction and what we can look forward to in the future.

WELDING OF TITANIUM

Birmingham, Ala.—A joint meeting of the *Birmingham* Section and the Birmingham Chapter of the American Society for Metals was held on December 16th, at Hooper's Cafe. Speaker was J. J. Chyle, director of research, A. O. Smith Corp., Milwaukee, and first Vice-President AWS. His talk on the welding of titanium was presented in an excellent manner.

ANNUAL CHRISTMAS PARTY

Chicago, Ill.—On Saturday evening, December 10th, the *Chicago* Section held its first annual Christmas party and dinner dance at the Lake Shore Club. Approximately 200 members, guests and their wives attended this gala affair.

The events of the evening were cocktails, dinner, door prizes, floor show and dancing.

To say that a "good time was had by all" would be putting it mildly, as everyone who attended is looking forward to next year's event.

SILVER BRAZING

Cleveland, Ohio—Silver brazing of all metals, including nonferrous types, was discussed by Alden W. Swift [illegible], at the December 14th meeting of the *Cleveland* Section held at the Manger Hotel with an attendance of 70 members and guests. Associated with Handy & Harman, New York, Mr. Swift is considered an expert in his field. His thorough presentation included a description of the proper silver brazing techniques and an explanation of how to attack specific problems.

Mr. Swift's talk was found most helpful and constructive by those present.

"How's Your Retail Credit Rating?" was the title of a coffee talk given by Richard A. Herrick, credit manager of Sterling-Lindner-Davis Co., Cleveland, which revealed how retail credit affects all of us in our purchases and what credit men know about us.

LADIES NIGHT

Denver, Colo.—On December 13th the *Colorado* Section held a Ladies Night, with an attendance of 31 members, wives and speakers. The dinner was held in the Festival Room of the Oxford Hotel.

Coffee speaker Allen Auten, a member of the Colorado Mountain Club, showed colored moving pictures taken during climbs up Devils Tower in North East Wyoming. This was very interesting.

The main speaker, Richard Tull,

SECTION MEETING CALENDAR

FEBRUARY 23

NIAGARA FRONTIER Section, Buffalo, N. Y. Sheraton Hotel, 8:00 P. M. "Processes and Equipment for Successful Welding Job" by H. J. Bichsel, Westinghouse Corp., Buffalo.

MARCH 1

NORTHERN NEW YORK Section. RPI, Troy, N. Y. "RPI Research Programs," by RPI personnel.

MARCH 2

NORTH CENTRAL OHIO Section. Plant visit, Gar Wood Industries, Inc., Findlay Division, Findlay, Ohio.

MARCH 5

LEHIGH VALLEY Section. Joint meeting with ASCE. "Structural Welding Design," by T. C. Kavanaugh, Consulting Engineer, Praeger & Kavanaugh, New York, N. Y.

MARCH 8

IOWA-ILLINOIS Section. 7:30 P.M. American Legion Club, Moline, Ill. "New Developments in Submerged Arc Welding," by R. A. Wilson, Lincoln Electric Co.

MARCH 13

DAYTON Section. 8 P.M. Dayton Engineers Club, 112 E. Monument Ave., Dayton, Ohio. "New Resistance Welding Techniques." Panel discussion. Carl Bertsche, Chairman.

MARCH 14

SOUTH FLORIDA Section. Miami, Fla. "Positioners," by Jack J. Jarms, Harnischfeger Corp., Milwaukee.

SAGINAW VALLEY Section. 7:15 P.M. Dinner meeting, High Life Inn, Saginaw, Mich. "Aspects of Welding Metallurgy."

MARCH 16

MARYLAND Section. Engineers Club, 6 W. Fayette St., Baltimore, Md. "Submerged Arc Welding," by Bob Wilson, Lincoln Electric Co.

MARCH 19

ROCHESTER Section. "Evaluating the Iron-Powder Coated Electrodes."

MARCH 20

HARTFORD Section. Villa Maria, Glastonbury, Conn. Dinner meeting. "Oxygen and Acetylene Handling, Cutting and Associated Process," by J. S. Douglas, Linde Air Products Co.

MARCH 21

PITTSBURGH Section. Joint meeting with Pittsburgh Chapter of ASCE and the Civil Engineering Section of the Engineers Society of Western Pennsylvania. "Current Techniques for the Production of Reliable Welds in Steel Structures."

MARCH 22

MADISON Section. Beloit meeting. "Importance of Metal Spraying," by C. J. O'Boyle.

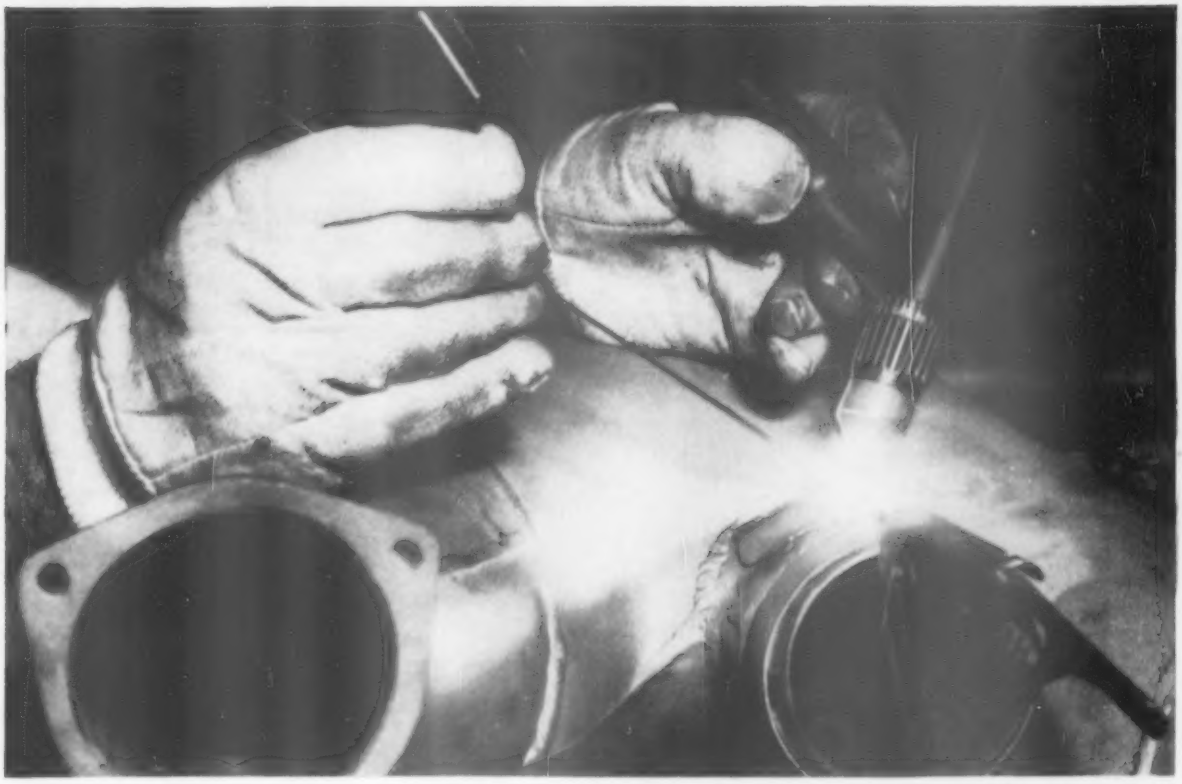
MARCH 23

MILWAUKEE Section. Milwaukee, Wis. "Gas Metal-Arc Welding," by R. W. Tuthill, General Electric Co.

MARCH 27

NORTHWESTERN PENNSYLVANIA Section. Erie, Pa. "CO_2 Shielded Consumable Electrode Arc Welding," by G. R. Rothschild, Research Labs., Air Reduction Co., Murray Hill, N. J.

Editor's Note: Notices to be published in any one given issue must reach Journal office prior to the first of the preceding month. Give full information concerning time, place, topic and speaker for meeting.



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CHICAGO SECTION HOLDS DINNER DANCE

The first Annual Christmas dinner dance of the Chicago Section was held on Dec. 10, 1955. Everyone had a good time, as shown above

president of the Denver Bar Association, talked about everyday common sense, legal advice concerning the average man, his problems relating to ownership of homes, cars and other property. He also discussed wills and trusts. This talk was also very interesting and well told.

PLANT VISIT

Middletown, Ohio—The 117 members and guests of the *Dayton* Section took part in a tour of the Armco Steel Corp. on November 8th. The visitors were able to observe first hand some of the principal operations involved in the production, rolling and processing of steel. This company is a pioneer in the manufacturing and processing of special purpose steels.

INERT-GAS WELDING

Dayton, Ohio—The regular monthly dinner meeting of the *Dayton* Section was held on December 13th in the Dayton YMCA Cafeteria and the Dayton Engineer's Club.

Edward J. Vogel of the Liquid Carbonic Corp. presented an interesting report of the latest developments in metal inert gas welding with CO_2. Questions answered by Mr. Vogel indicated appreciable interest by members.

A movie on Guided Missiles was shown through the courtesy of the U. S. Army, Fort Mead, Ga.

CARBON DIOXIDE WELDING

Detroit, Mich.—The *Detroit* Section met in the auditorium of the Engineering Society of Detroit on Friday, November 11th, to hear R. W. Tuthill (M'52), of the General Electric Co., discuss carbon dioxide welding. Motion pictures were used to show, at greatly reduced speeds, what takes place around the arc when the several different methods are employed. The limitations of the various methods were recognized along with their possibilities. Mr. Tuthill's discussion left the group well entertained and well informed and it was generally agreed that the meeting was one of the most successful held to date. About 150 were present for the meeting, and somewhat more than half of these gathered for dinner beforehand and heard S. F. Poole of the Penola Oil Co. tell of petroleum research, in a most vivid manner, while enjoying after-dinner coffee.

CLEVELAND SECTION ADDRESSED BY SWIFT

Shown in the background is the speaker's table during the December 14th meeting at the Manger Hotel. Third from right is Alden W. Swift, guest speaker; fourth is Al Stern, Section Chairman

Shown with delighted fellow members is one of the few lady members of the AWS, Miss Eva M. Kamatz

Enjoying a humorous moment are, left to right: C. B. Herrick, Bob Henry, Harold Bloom and Harry McBride

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SPEAKS IN DETROIT

R. W. "Tut" Tuthill was the guest speaker at the November 11th meeting of the Detroit Section. He is pictured here with Al Last, technical chairman (*left*) and J. E. Rainey section chairman (*right*)

INERT-GAS WELDING

Orange, Tex.—The Sabine Division of the *Houston* Section met on Thursday, Dec. 1, 1955, for dinner and meeting at the American Legion Hall in Orange.

Some 50 members and guests turned out to hear Warren G. Gumm AWS, of the Linde Air Products Co., Houston, present an excellent semitechnical talk on "Inert-Gas Metal-Arc Welding." Mr. Gumm used slides and motion picture film to illustrate his talk.

A sound color movie entitled "The Wettest Inch" showing the complete laying operation of a large cross-country pipe line from Port Arthur, Tex., east to the New Orleans, La., area was shown through the courtesy of the Texas Co. of Port Arthur.

ADDRESSES SABINE DIVISION

W. G. Gumm spoke before the Sabine Division of the Houston Section on Dec. 1, 1955. His topic was "Inert-Gas Metal-Arc Welding"

ANNUAL CHRISTMAS PARTY

Huntington Park, Calif.—The Fall activities of the *Los Angeles* and *Long Beach* Sections and the *Aircraft and Rocketry Panel* were brought to a successful conclusion on Thursday evening, Dec. 1, 1955, with the annual Christmas stag party. The 300 or more who attended enjoyed good fellowship and a well-balanced show. The dinner and pleasant surroundings provided by the Elks Lodge of Huntington Park were most enjoyable.

CARBON DIOXIDE WELDING

Madison, Wis.—Fifty-five members and guests of the *Madison* Section met at dinner on October 27th at the Eagles Club House to hear John Koss AWS, of the A. O. Smith Corp., Milwaukee, deliver a short and to-the-point discussion on carbon dioxide as applied to gas metal-arc welding. The introduction of carbon dioxide in the welding of mild steels proved very versatile as illustrated by slides.

RESISTANCE WELDING ADVANCEMENTS

Madison, Wis.—A Christmas party preceded the regular meeting of the *Madison* Section held on December 15th at the Eagles Club House. Fred Theiler, first vice-chairman, played the part of Santa Claus and did an excellent job of distributing the gifts. Prior to this, the entire group sang Christmas carols.

Featured speaker at the regular meeting was Karl W. Matthes AWS, of the Precision Welder & Flexopress Corp., Cincinnati, Ohio. Mr. Matthes' subject "Advancements in Resistance Spot Welding" was of genuine interest to one and all. His talk was accompanied by slides which pointed out very clearly the advancements that have been made in resistance welding. Each slide presented was given careful attention and basic theories were well covered. Mr. Matthes concluded his part of the program by showing some samples of aluminum, tungsten and other metals welded successfully with resistance welding applications.

PLANT VISIT

Benton Harbor, Mich.—On November 17th, 55 members and guests of the *Michiana* Section had an opportunity to see the new Clark equipment plant for the first time since its opening for production. Many new items not fabricated before are now being produced in this new and modern plant.

1955 MEMBERSHIP DIRECTORY

The 1955 Membership Directory issue is now available to SOCIETY members, without charge.

For your copy, write AWS Headquarters, 33 W. 39th St., New York 18, N. Y.

IRON-POWDER ELECTRODES

Newark, N. J.—Eighty-eight members and guests of the *New Jersey* Section were present at a dinner meeting on "National Officers Night" Dec. 13, 1955 held at the Essex House Hotel, Newark, N. J. National officers present were: J. H. Humberstone, AWS President; J. G. Magrath, AWS Secretary; R. S. Donald, AWS Treasurer; C. P. Sander, 2nd Vice-President; Frank Mooney, AWS

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OFFICERS FETED BY NEW JERSEY SECTION

Seated at the head table are, reading left to right: F. J. Mooney (hidden from view), C. P. Sander, E. DeLiberti, J. H. Humberstone, J. E. Riley, D. B. Howard, R. S. Donald, N. F. Kiernan, J. G. Magrath, J. W. Mortimer, C. E. Jackson, J. Hila (hidden from view)

President Joseph H. Humberstone is shown during his review of Society activities

Technical Speaker D. B. Howard delivering his talk on iron-powder electrodes

Assistant Secretary; J. W. Mortimer, AWS Director at Large, and D. B. Howard, Director District No. 2, who was the speaker of the evening.

President Humberstone reviewed the SOCIETY's activities and reported upon current membership growth. Secretary Magrath gave a concise description of the SOCIETY's next edition of the WELDING HANDBOOK.

Speaker Donald B. Howard is Supervisor of Metallurgy and Welding at the General Laboratories Research and Development Department of American Car and Foundry, Berwick, Pa. His subject "Evaluating the Iron Powder Coated Electrodes" was very well presented and spiced with humor. Illustrating with slides showing fractured test specimens and research data, Mr. Howard gave a complete review of the extensive test procedures and final evaluation which included: (1) all-weld metal tension test; (2) guided bend test; (3) macro and micro examination; (4) impact resistance tests; (5) operating characteristics.

H. L. Hoffman conducted the question and answer period which was followed by the usual after meeting snack and get-to-gether.

WELDED PIPING

New York, N. Y.—"Piping Problems Related to Welding" was the subject of a paper presented to the *New York* Section on Dec. 13, 1955, by Helmut Thielsch [illegible], metallurgical engineer with the Grinnell Co. of Providence, R. I.

Mr. Thielsch, whose background includes work with the Welding Research Council, the Lukens Steel Co., and Allis-Chalmers Mfg. Co., in addition to his present employer, was well qualified to give a very comprehensive coverage of pipe failures. He explained that they were due to the following causes: (1) materials, (2) manufacture, (3) welding, (4) excessive service, (5) design.

A clear and comprehensive set of slides were shown to demonstrate the points to be considered, and each one present had a most educational and enjoyable evening.

Before the main speaker, W. H. Bicknell, service engineer for the Bell System, gave a talk entitled "Nike, the Rocket's Red Glare" which was most fascinating and timely. Mr. Bicknell used models and an excellent film to demonstrate his talk and gave the audience a clear understanding of the elaborate precautionary measures that are being taken in our defense by the Government.

The meeting was held at the Schwartz Restaurant, 54 Broad St., New York City.

IRON-POWDER ELECTRODES

Buffalo, N. Y.—On the first of December, in the aftermath of a relatively severe blizzard, the *Niagara Frontier* Section held a regular dinner meeting at the Hotel Sheraton with an attendance of 45 members despite the weather conditions. Also at the meeting was a visitor of the Sabine Division, Houston Section, in the person of Robert J. O'Brien [illegible], who is associated with the Columbia Southern Chemical Corp., Lake Charles, La.

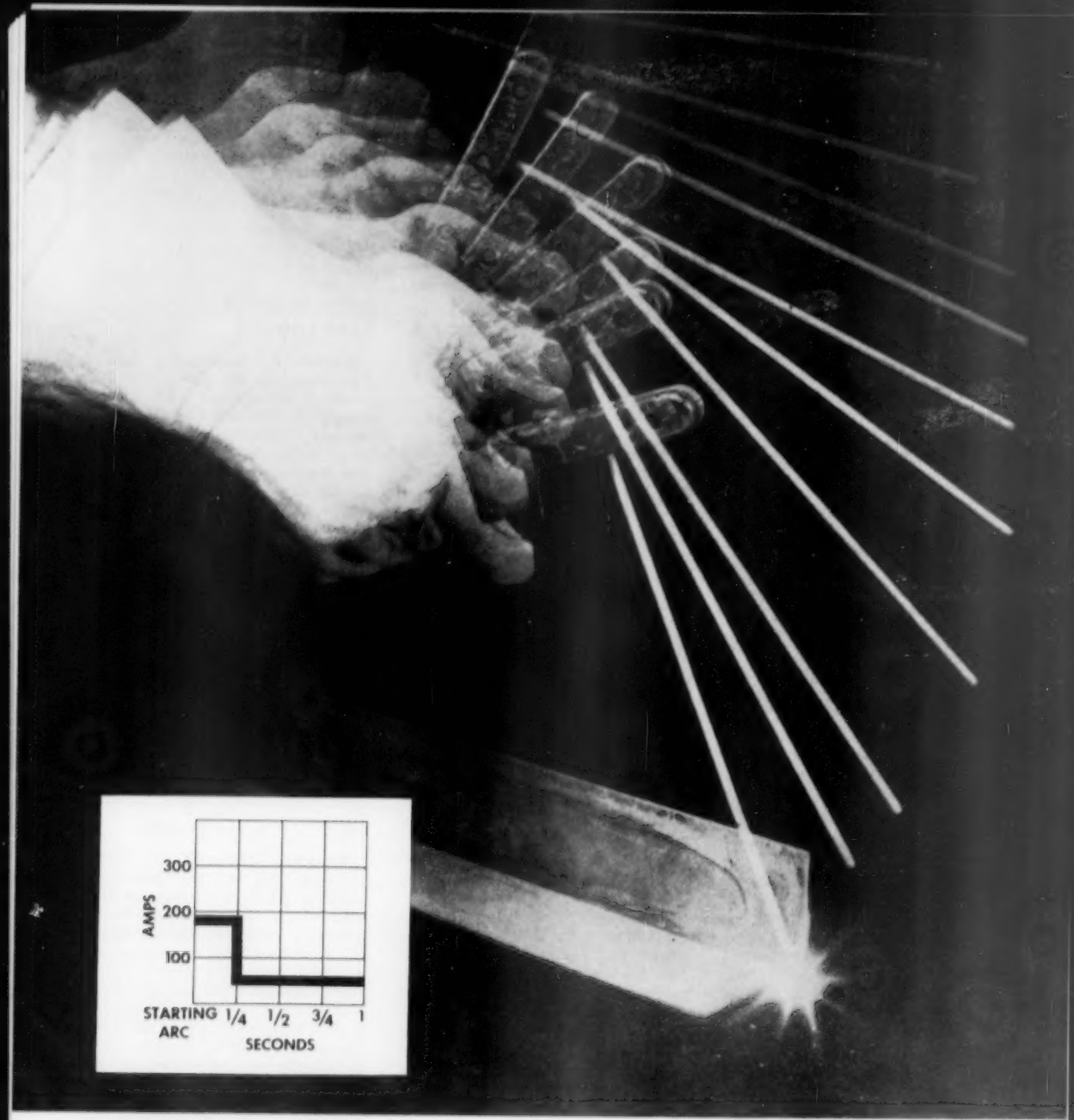
The principal speaker was Donald B. Howard of the American Car and Foundry Corp., Berwick, Pa., and director of district number 2, AWS. Mr. Howard's talk dealt with the evaluation of iron-powder coated electrodes for production use and he discussed specifications, testing, general capabilities and evaluation of these electrodes. The talk was of general interest and well received.

BRITTLE FRACTURES

Knoxville, Tenn.—W. S. Pellini, superintendent of the Metallurgy Division of the Naval Research Laboratory in Washington, D. C., was the speaker at the joint dinner meeting of the *North East Tenn.* Section with the American Society for Metals held on November 16th at the S. & W. Cafeteria in Knoxville.

Mr. Pellini, who received the Washington Academy of Science award in 1954 for achievement in the Engineering Sciences, gave an excellent talk on "Brittle Fracture—Cause and Prevention." His talk, accompanied by slides, presented an analysis of the causes of brittle fracture in large welded structures. Inadequate notch ductility in metals, and low temperature was presented as the primary causes of brittle fracture. The laboratory tests in determining the cause and the development of improved steels for low temperature use were discussed, and determining the specifications needed to procure the improved steels for low temperature use was described.

The meeting was indeed a very interesting one and beneficial to everyone present.



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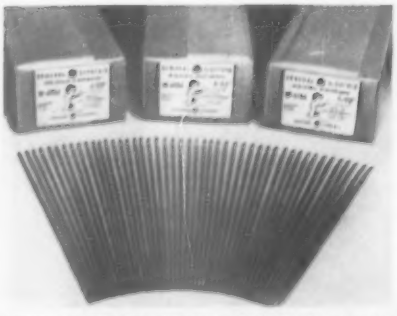

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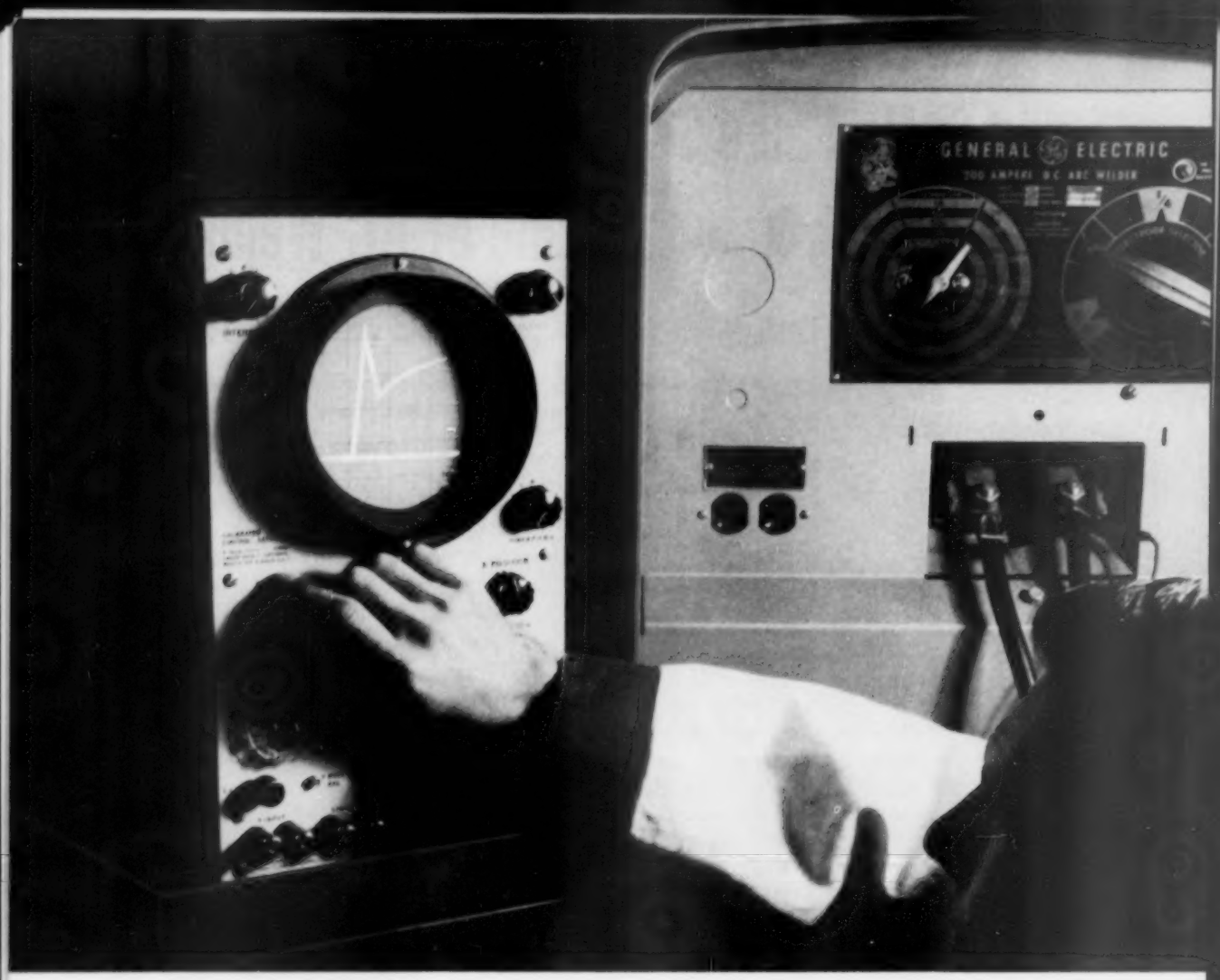

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EXTRA-STURDY construction is shown in this demonstration. Five nickels stand on edge while welder is operated at full load.

GENERAL ELECTRIC

EUROPEAN WELDING METHODS

Erie, Pa.—Roger W. Clark [AWS], of the General Electric Co., Materials and Processes Lab., Schenectady, N. Y., was the featured speaker at the November 29th meeting of the *Northwestern Pennsylvania* Section held at the General Electric Community Center.

Mr. Clark was one of the three U. S. representatives on the OEEC European mission 250 and obtained a detailed first-hand picture of welding operations in many of the European countries this side of the iron curtain. His talk was a report on the findings of this mission.

FUTURE OF WELDED SHIPS

Pascagoula, Miss.—E. R. Hammett, production manager and assistant vice-president, Ingalls Shipbuilding Corp., spoke on the future of welded ships at Pascagoula at the dinner meeting of the *Pascagoula* Section held on October 5th in the Ingalls Shipyard Cafeteria.

FLOATING EQUIPMENT

Pascagoula, Miss.—Robert H. Macy [AWS], technical assistant to the president of Ingalls Shipbuilding Corp., Pascagoula, was the speaker at the November 9th dinner meeting of the *Pascagoula* Section held in the Shipyard Cafeteria, Ingalls Shipyard. Mr. Macy's topic was "Specialized Floating Equipment."

SIMPLIFIED WELDING METALLURGY

Peoria, Ill.—The December meeting of the *Peoria* Section was held Wednesday evening, Dec. 21, 1955, at the Mecca Supper Club.

The speaker was Anton L. Schaeffler [AWS], of Allis-Chalmers Co. of Milwaukee, Wis. His subject was "Simplified Welding Metallurgy for Welders and Welding Supervisors."

The talk was presented with slides, pointing out metallurgical problems encountered in the welding of low carbon steels, low alloy steel, stainless steel and dissimilar steels. Also, the speaker explained by the use of proper procedures how to overcome such defects as bead cracking, cracking in the heat-affected zone, porosity, etc.

Forty-one members and guests were present.

MARINE WELDING

Philadelphia, Pa.—A joint meeting of the Society of Naval Architects and Marine Engineers and the *Philadelphia* Section was held on Friday evening, Dec. 16, 1955, at the Engineer's Club. The speaker was Norman L. Mochel [AWS], manager of Metallurgical Engineering of the Westinghouse Electric Corp. at Lester, Pa.

Mr. Mochel traced the development of the steam turbine from the first successful one used to propel a ship in 1897 down to the present nuclear power plant in the submarine *Nautilus*. He pointed out how welding has made it possible to develop the enormous power plants of today by eliminating iron castings and forgings used in earlier days to steel plate fabrication used today. Alloy steels for higher temperatures are made available by welding. Large bull gears in the turbine gear reduction are fabricated thus making it possible to use nickel, chrome, moly steels in the rims which have 300 Brinell hardness.

Atomic power unit will use welding requiring the greatest reliability and new metals. Overall picture of nuclear power will require alloy steels up to 9 in. thick. Stainless lined coolant pump uses 3½-in. thick welded stainless steel.

Mr. Mochel pointed out how the development work of the AWS and the Marine Engineers have contributed greatly to the development of marine power plant systems.

At the end of the speaker's talk there was a very interesting discussion pointing out in particular how the development of the new low hydrogen alloy electrodes have made this work possible.

PLANT TOUR

Tacoma, Wash.—One of the largest turnout of members and visitors of the *Puget Sound* Section took place on November 10th when they visited the Kaiser Aluminum Plant in Tacoma. Before the tour, Wayne Clukey, superintendent of development for the Kaiser Corp., gave a short talk on the manufacturing process at the Tacoma works. After his talk Mr. Clukey led a tour through the plant.

The tour of the pot lines, foundry and maintenance shops was extremely interesting since the tour leaders were experienced management personnel.

Mr. Clukey, in his speech, pointed out that there will be unlimited uses for aluminum in the future if welding can keep up with the demand for

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proper welded sections. The growth of aluminum use in this country will be limited only by the welding problems.

PLANT TOUR

Corning, N. Y.—On Saturday, October 8th, at 3:00 P.M. the *Rochester* Section members and their families gathered at Corning N. Y., for a trip through the Corning Glass Center. After touring the center a social hour including dinner was enjoyed at the Baron Steuben Hotel. Another visit to two of the Corning Glass plants producing TV picture tubes and glass tubing proved to be very interesting. About 9:30 P.M. the group headed for home tired but well pleased at the day's activities. This was the first time that the wives of the members accompanied them on a plant tour, but judging from the favorable comments, they may be included in future events.

CARBON-DIOXIDE WELDING

Rochester, N. Y.—On Nov. 21, 1955, the *Rochester* Section held its first Technical Session of the season. Gilbert Rothschild [illegible], section head, Metallurgical Division, Air Reduction Co., Murray Hill, N. J., was the speaker. His subject was "Inert-Gas Shielded Metal-Arc Welding Using Carbon Dioxide Gas." The talk was supplemented with slides and a movie which illustrated the results that may be expected under certain conditions when using carbon dioxide gas. Mr. Rothschild is to be congratulated on his presentation, especially for pointing out the bad results that will occur when this gas is improperly used or when applied on certain materials.

WELDING EQUIPMENT

Saginaw, Mich.—The *Saginaw Valley* Section held its monthly dinner meeting on Dec. 8, 1955, at the High Life Inn. This being "past-chairman night," there were 80 members and guests present to honor past-chairmen S. Fisher; R. Ladd, who gave a brief review of the past history of the Section; I. Mattson; W. Moehring; J. Neuman and S. Spice.

The main speaker of the evening was Earl B. Stavely, Jr., application engineer of General Electric Co., who gave a very informative and interesting talk on "Power Requirements and Supply for all Types of Welding Equipment."

ANNUAL DINNER DANCE

St. Louis, Mo.—The *St. Louis* Section held its annual dinner dance at Norwood Hills Country Club on December 10th.

The 82 members and guests present enjoyed a delightful evening of fun. Dancing followed dinner and attendance prize awards.

PLANT TOUR

Santa Clara, Calif.—The regular meeting of the *Santa Clara Valley* Section was held on Dec. 8, 1955. Following a good dinner, 117 members, their wives and guests viewed exhibits of Fiberglas Products in the display room of Owens-Corning Fiberglas which was of considerable interest to the ladies as well as to the members. Preceding the plant tour, there were two short talks by the following officials of the Fiberglas Co.: R. M. Daiss, plant manager, who spoke on "Fiberglas and You"; and G. M. Falling, chief engineer, Pacific Coast Division, who spoke on "The Design and Fabrication of the Manufacturing Facilities at Fiberglass."

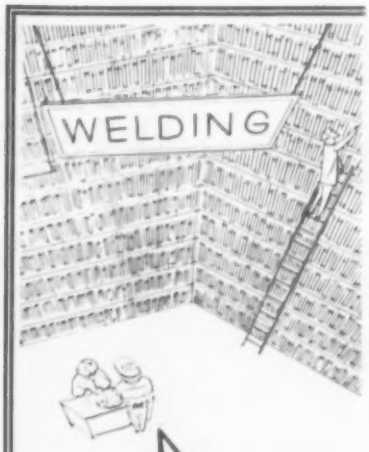
INERT-ARC WELDING

Shreveport, La.—The December meeting of the newly formed *Shreveport* Section was held on December 15th at the J. B. Beaird Co., Inc., Cafeteria. Speaker was Larry Kelly, manager of Engineering Service for the Southern Region, Linde Air Products Co. His subject was "Welding with the Inert-Gas-Shielded Arc Processes." Mr. Kelly gave the history on the origin of inert-gas-shielded arc welding. He described tungsten-electrode and consumable-electrode processes giving effect of various shielding gases, reverse and straight polarity, and type of material being welded. Ultra slow motion film was used to show droplet transfer using different gases. An Alcoa film on shop applications of inert-gas-shielded processes was also shown.

Coffee speaker was Ward Champion [illegible] District Manager of the Air Reduction Sales Co., who put on a show using liquid gas as his props. Mr. Champion supplemented his act with comments on application oddities and hazards of liquid gases.

WELDING TRAINING

Miami, Fla.—The regular monthly meeting of the *South Florida* Section was held on Wednesday, Dec. 14, 1955, at 8:30 P.M. at the Melrose Hall in Miami. Due to the approaching holidays this meeting was moved up one week.



What's New on Welding Space Ships?

The Welding Journal provides the most complete library of information on the art and science of welding available . . . anywhere. If you have a product for the welding or allied industries, the Journal's pages will reach your market.

Guest speaker was Prof. Murray I. Mantell, chairman of the Civil Engineering Department, University of Miami. His subject "Welding in the Engineering Curriculum" was very interesting, as he outlined the general procedure in teaching and training of the students in their particular field. He mentioned among others a project now in process at the University namely a 70-ft span steel foot bridge over the student Lake Canal which is being erected, assembled and welded by the members of the A.C.E. Club at U.M. and thanked the AWS South Florida Section for their cooperation; the Miami Welding Supply through Al Thompson, who is furnishing welding equipment and material; and the Wingerter Laboratories, through Tom Berg, who is qualifying the student members that are to do the welding as well as inspecting their work while in progress.

There was a question and answer period which proved most interesting. It was agreed that this Section take as a project the part training employment of the student engineers so that they may obtain practical experience relative to their training and education.

BRAZING MACHINERY

Syracuse, N. Y.—The December dinner and technical meeting of the *Syracuse* Section was held in the Hiawatha Room of the Hotel Onondaga on December 14th.

The coffee speaker, Prof. Brown of Syracuse University, College of Forestry, gave a very interesting discourse on the subject of forestry.

The technical speaker, Charles A. MacFadden, sales engineer of the Selas Corp. of America, Philadelphia, Pa., gave a very interesting and informative talk on "Automatic Brazing Machinery."

He explained in detail the fundamental operations such as cleaning, fluxing, application of filler metal, and postheating operations including heat treating, which are involved in production brazing.

A series of slides were also shown to demonstrate machinery built for customers to do specific jobs.

PLANT TOUR

Ionia, Mich.—The December meeting of the *Western Michigan* Section was held on December 19th at Ionia, Mich.

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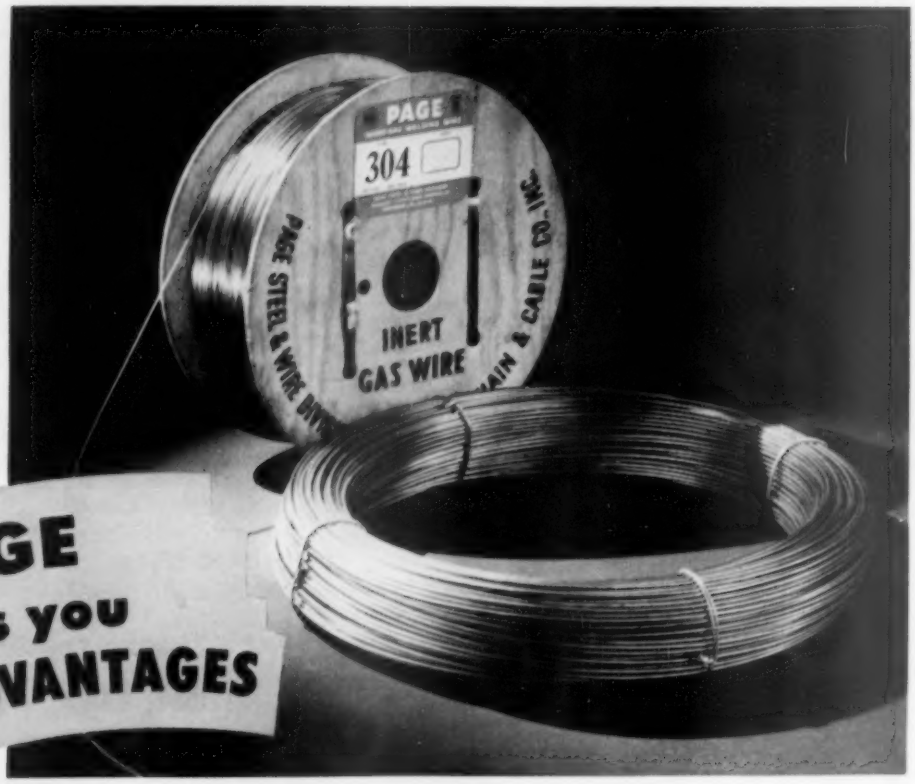

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CARBON STEEL • **Any carbon from Armco (.025 max.) to high carbon (.90—1.10)**

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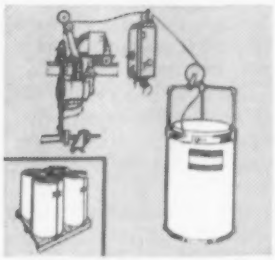

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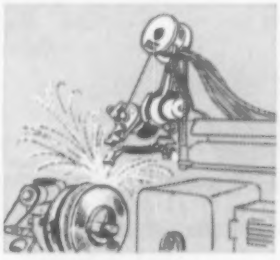

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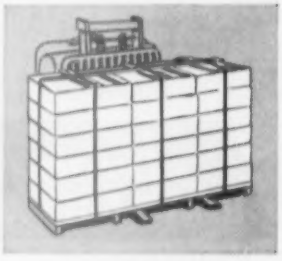
PAGE Inert Gas Welding Wire is available on reels: Precision thread-wound on twenty-five-pound, non-returnable reels to fit all popular inert gas welding machines.



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Better Value

Meeting was a plant tour through the Ionia Mfg. Co. where they manufacture Buick and Mercury station wagon bodies.

Arrangements were made for the dinner and tour by Glen Hickok, assistant chief engineer of the plant.

There were 66 members and guests for the dinner which was held in the Masonic Temple. They were joined by 6 more for the plant tour.

The tour was well arranged and planned, and took in several kinds of welding, soldering and painting as well as installing the upholstering and trim. Guides were very cooperative and could answer the many questions that were asked.

There is always much interest shown in plant tours in the Western Michigan Section and this was one of the best held to date.

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*TWECO-LITE, the new flexible ALUMINUM welding cable that weighs half as much, lasts longer, and costs less

a product of TWECO PRODUCTS CO. Wichita 1, Kansas

MACHINE CUTTING

Worcester, Mass.—The *Worcester* Section held their third meeting of the season on Monday evening, December 5th, at the Hickory House.

The speaker of the evening Richard F. Helmkamp, machine cutting specialist, Air Reduction Sales Co., New York, gave a lecture on his specialty "Machine Cutting." Mr. Helmkamp particularly stressed the various cutting tips available to the trade. He talked on pressures, speeds, etc. and dealt with piercing, stack cutting, and covered every phase of the subject. A very attentive audience asked many questions which were answered to the satisfaction of all. Following the lecture, Mr. Helmkamp showed a number of "still" pictures and wound up the evening with a short moving picture which showed contour beveling with the electronic tracer. This was a very worth-while meeting.

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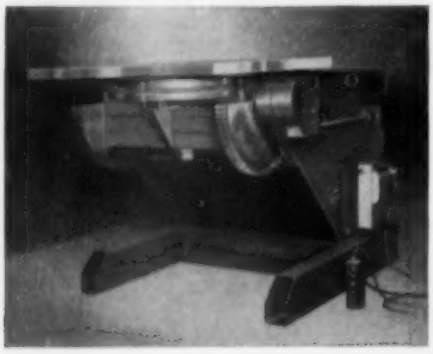
Have BACKBONE

HD Models of ARONSON WELDING POSITIONERS feature the basic BOX TYPE CONSTRUCTION with its advantage of extreme RIGIDITY — Holds your weldments *Steadier* and *Safer* — Affords Protection of Motors and Controls which are mounted *inside* the Box Chassis, out of harm's way — and provides WORKING PLATFORM area on the *flat* steel top.



No Other Type Construction can afford the Rigidity and Strength, and provide the Necessary Backbone for the mechanism that guarantees the user of an ARONSON POSITIONER the Fastest, Highest Precision Welds, and with Complete Safety.

With Table in the Flat Position and with Table Height at Minimum Setting, there is nothing projecting above the top of the chassis to limit the diameter of work you can swing, no column to get in the way, nothing for the weldment to smash into!

4-POST ADJUSTABLE BASE carries out the advantages of the Box Design, affording maximum effective Column of Support many times stronger and more rigid than any single post design.

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MAINTENANCE WELDING

Lancaster, Pa.—"Maintenance Welding" at Bethlehem Steel was the interesting subject presented by R. E. Metius, to the *York-Central Pennsylvania* Section on December 13th at the Arcadia Cafe, in Lancaster, Pa.

Mr. Metius is the welding engineer at Bethlehem's Sparrows Point Plant. Slides showing the rebuilding of 120-in. diam steel gears, 20-ton forge frames, and buildup and hard surfacing of drives and rolls were instructive. Special techniques in welding, sequence of passes, positioning and heat treatment are required for each job.

G. A. Reinhard, Jr., chief engineer, Armstrong Cork Co., presented an entertaining after-dinner talk on welding procedure and practices used at Armstrong.

Attend
1956 National Spring Meeting
May 7–11
Buffalo, N. Y.

New Members

Effective December 1, 1955

MEMBERSHIP CLASSIFICATION

A—Sustaining Member B—Member C—Associate Member

D—Student E—Honorary Member F—Life Member

Total National Membership December 1, 1955

Members	*5,260*
Associate Members	*5,581*
Student Members	*214*
Life Members	*16*
Honorary Members	*10*
Sustaining Members	*125*
Total	**11,206**

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Starr, Robert D. (C)
Vorge, Herbert G. (B)

CHATTANOOGA

Chadwick, Philmer J., Jr. (C)
Milligan, C. G., Jr. (C)
Proctor, E. S., Jr. (C)

CHICAGO

Akin, Richard K. (B)
Bruce, S. S., Jr. (C)
Dahlberg, W. F. (B)
Fleek, Norman L. (C)
Greenleaf, Edwin M. (C)
Heine, Arthur B. (C)
Kuta, Henry S. (B)
Opie, Henry C. (B)
Sims, J. F. (C)
Wickum, Roy S. (C)

CINCINNATI

Spargur, Charles R. (C)

CLEVELAND

Blumenstein, W. K. (C)
Boyle, Robert E. (C)
Hnat, John, Jr. (C)
Hubak, Edward F. (C)
Kaderavek, Robert (C)
Kleinhen, W. G. (C)
Lohmeyer, Walter J. (C)
Neiman, Andrew B. (C)
Pocker, Richard L. (C)
Raidy, Ralph R. (C)
Slotterback, E. E. (B)
Tabor, Robert M. (C)
Thomas, G. W., Jr. (B)
Tyrrel, John F. (B)

COLORADO

Abercrombie, A. D. (B)
Garlington, Jesse M. (B)
Foehl, Paul J. (B)
Kauth, John E., Jr. (B)
Mismas, Frank J. (B)
Pardee, Victor J. (B)

DALLAS

McCormick, S. D. (C)
Page, Robert D. (C)

DAYTON

Bosse, Robert I. (C)
Eckins, Reynold R. (C)
Stratton, Richard L. (C)

DETROIT

Barrett, Joseph (C)
Cardella, Joseph (C)
Custance, Donald E. (B)
Deleo, Peter D. (C)
DiPirro, Anthony A. (C)
Gates, Raymond J. (C)
Hackett, Albert E. (B)
Hutcheson, J. D. (B)
Kimbleton, Cecil (B)
Klewinowski, Joseph J. (B)
Leamon, Richard H. (B)
Long, William E. (B)
Loup, Ronald L. (B)
McRoberts, J. F. (C)
Payne, William B. (C)
Radcliff, Harry S. (B)
Raeside, Dave (B)
Rose, Harry S. (B)
Russell, Don D. (B)
Sarlauskas, Joseph D. (B)
Smith, Richard E. (B)
Soehner, William C. (B)
Tindall, Raymond D. (C)
Voland, Kirt (C)

HARTFORD

Corrigan, Gervas F. (B)
Stohr, John H. (D)

HOLSTON VALLEY

Winn, J. T. III (C)

HOUSTON

Barrera, Jimmy V. (C)
Brennan, Paul J., Jr. (C)
Clark, Ross (C)
Compton, Joe E. (C)
DeLeon, Francisco (C)
Heimer, Elmer G. (B)
Kiel, Floyd E. (B)
Lampkin, J. S., Jr. (C)
Ramirez, Joe H. (C)
Smith, Earl A. (C)
Spillar, John A. (B)

INDIANA

Batuello, Baptiste (B)
Ritterskamp, James J. (B)

IOWA

McGlothlen, Lemmuel F. (C)

IOWA-ILLINOIS

Cameron, Hugh C. (B)
Carmaghi, John (B)
Erickson, George, Jr. (B)
Martin, William M. (C)
Zenkel, Francis A. (B)

LEHIGH VALLEY

Elly, Leonard P. (C)
Gallant, Oscar J. (C)
Hartranft, Russell (C)
Ruksnaitis, Anthony (C)

LONG BEACH

Allen, Ronald (D)
Beard, Darrell F. (D)
Crockett, Dave (D)
Haight, Brian R. (D)
Hodgerson, Harold L. (D)
Horton, Noah (D)
James, Arlie M. (D)
Roberts, Earl E. (C)
Smith, Norman (D)
Tanaka, Tom T. (D)
Telk, Charles L. (D)
Williams, Roger F. (D)
Woods, John L. (B)

LONG ISLAND

Donnelly, John M. (C)
Luby, William J. (C)

LOS ANGELES

Adams, L. B. (C)
Amos, Virgil L. (C)
Asbury, H. (C)
Austive, Merlin L. (C)
Boulton, Franklin F. (C)
Burleson, Catherine (C)
Carroll, Vinton (D)
Chaisson, Philip (D)
Clark, Earl (D)
Clark, R. T. (D)
Combs, R. L. (B)
Conley, Kenneth H. (D)
Crockett, Reid (B)
Cye, Joe (C)
Dahl, Wayne E. (B)
Dingman, James V. (D)
Escarcega, Robert N. (D)
Fietze, Walter (C)
Fox, Malcolm L. (C)
Gatzek, Leo E. (B)
Goodman, Henry (D)
Gould, Harold (C)
Hahne, Roy L. (C)
Hartz, George A. (C)
Hinkle, Samuel E. (D)
Holmes, William W. (C)
Howard, C. E., Jr. (C)
Johannsen, Glenn W. (C)
Keene, Frank (C)
Kelley, Charles H. (D)
Kirkland, Otis L. (D)
Kranen, John F. (D)
Lewandowsky, Frank (D)
Lewis, Oliver (C)
Lippeatt, Duncan H. (B)
Lofstrom, Arnold (B)
Marden, Jonathan (C)
Martin, Ralph G. (C)
Maxim, Chester M. (B)
O'Morrow, Roy E. (C)
Persall, Floyd (D)
Phelan, Robert J. (B)
Pollock, J. L. (D)
Richards, L. B. (C)
Richardson, Fred R. (C)
Roberts, Wilford A. (C)
Rodenbaugh, E. S. (B)
Schumacher, Richard (D)
Slagle, R. M. (D)
Spence, John R. (B)
Stone, Frank J. (D)
Sweet, William J., Jr. (D)
Ter Veer, Reynell (D)
Tipton, R. K. (D)
Walker, Wesley T. (D)
Waltn, Elwin R. (D)
Warren, Lee (B)
Wolfe, Burton L. (B)
Wolfe, Edward S. (B)
Wolitski, Joseph (D)
Yoakum, Marshall F. (B)
Yoakum, William J. (B)

LOUISVILLE

Denison, James H. (C)
Gephart, George L., Jr. (C)
Wilson, Fred T. (C)

MADISON

Derusha, Roger H. (D)
Hedgelock, Hollis W. (B)
Peterson, Paul A. (B)
Shaw, Lauren R. (B)
Wiedenbeck, Theodore, Jr. (C)

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Remanufactured ignitrons come to you at prices much lower than new tubes. Savings average 28% on the three ignitron types now being remanufactured—GL-5551, GL-5552, GL-5553-A. And remember: General Electric's new-tube warranty on remanufactured ignitrons assures you of new-tube performance!

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TYPE	DOLLARS SAVED	% PRICE SAVED
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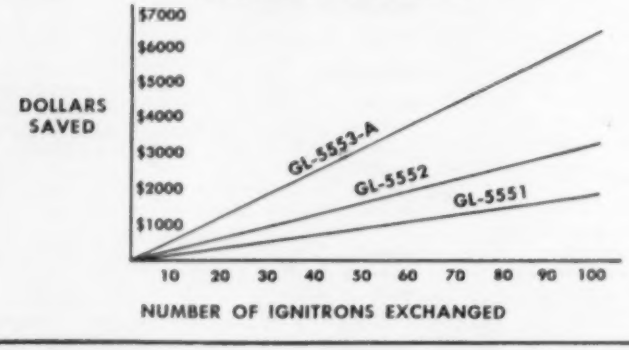
GL-5552	28.50	28%
GL-5553-A	63.00	29%

HOW YOUR SAVING INCREASES WITH NUMBER OF IGNITRONS EXCHANGED



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ALL-NEW CATHODE ASSEMBLY

Every G-E remanufactured ignitron gets a complete new cathode assembly, no matter what the condition of the tube. Cathode parts are the components most subject to wear and breakdown after long, hard service. Key new parts supplied are:

NEW IGNITOR

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STABILIZED-STEEL JACKETS—A G-E "PLUS"!

Stabilized stainless-steel water jackets are exclusive with G-E ignitrons. They explain why General Electric alone can offer you remanufactured ignitrons with new-tube performance. Only *stabilized* steel will undergo a second high-temperature baking with no corroding after-effects!

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General Electric's Remanufactured Ignitron Exchange Plan provides a standard new-tube warranty with each remade G-E ignitron tube. This is your assurance of new-tube performance.

Each remanufactured G-E ignitron has been thoroughly tested under the same conditions as new tubes. To be approved for your use, the remade ignitrons are required to perform at new-tube ratings and satisfy the highest quality standards.

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MAHONING VALLEY

Hoffman, Ralph (C)

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Adams, Clyde H. (C)
Kova, Lewis R. (B)
Shaw, Edward M. (C)
White, Samuel D. (C)

MICHIANA

Herman, Chester J. (C)
Woods, Glenn H. (C)

MILWAUKEE

Borer, Herbert W. (C)
Castinglioni, Caesar P. (C)
Dekker, G. J. (C)
Falque, Paul E. (C)
Gannon, Joseph J., Jr. (C)
Getz, Roland L. (C)
Stacey, Bert (C)
Zimprick, John W. (B)

NEBRASKA

McColley, Edward M. (C)

NEW JERSEY

Ayling, Thomas H., Jr. (C)
Brien, Robert E. (B)
Feitner, Charles A., Jr. (B)
Fenelon, Dennis J. (C)
Fenelon, William F. (C)
Kalata, Stephen F. (C)
Krautter, Henry J. (C)
Kushner, Joseph (C)
Russo, Joseph (B)

NEW ORLEANS

Fazzio, Sam (C)

NEW YORK

Laurie, Roy (B)
Rigali, George (C)
Robinson, Jerome L. (B)
Sommer, Armin B. (B)

NIAGARA FRONTIER

Schlieder, Harley J. (C)

NORTHERN NEW YORK

Huston, George L. (C)

NORTHWEST

Gulbrandson, E. A. (C)
Halley, Richard W. (B)
Maynard, M. J., Jr. (C)
Schmitt, John G. (B)
Weber, E. P. (C)

NORTHWESTERN PA.

Griffin, George N. (C)
Renaud, Thomas G. (C)

OLEAN-BRADFORD

Barnes, Ralph L. (C)
Peterson, Stanley S. (B)

PHILADELPHIA

Daly, James A., Jr. (C)
Kennedy, Albert B. (C)
Moody, N. F. (C)
Morley, William R., Jr. (C)
Rawson, James (C)
Wendt, Edward A. (C)

PITTSBURGH

Akers, Vincent P. (B)
Bradbury, John H. (C)
Carroll, John R. (B)
Cooper, Anthony L. (C)
Lapinski, Chester J. (C)
Lewis, Robert J. (B)
Mattingly, Richard E. (B)
McCallan, C. A. (B)
Mears, Harold W. (B)
Rahn, Dorothy J. (B)
Reynolds, Carle C. (B)
Simmons, F. A. (B)
Visintainer, A. W. (C)

PUGET SOUND

Buchanan, Arthur L. (B)
Morris, J. B. (C)
Wallington, James E. (B)
Weeks, B. E. (B)

RICHMOND

McCord, J. H. (C)
Renick, Edward O'F. (C)

SAGINAW VALLEY

Kushmaul, Donald R. (C)
Minckler, G. M. (D)
Rough, Lewis (D)
Tupes, Robert (C)
Vlaciha, Leonard R. (D)
Zdrojkowski, Floyd J. (D)

ST. LOUIS

Fledhouse, Harold E., Jr. (C)
Inslee, Thomas E. (C)
McLamar, Vernon M. (C)
Notvest, Kenneth (B)
Nyberg, Ned (C)
Young, Robert E. (B)

SAN FRANCISCO

Arnold, Frederick C. (B)

SANGAMON VALLEY

Reinholt, W. H. (C)
Ward, Virgil E. (C)

SANTA CLARA VALLEY

Anderson, Carl D. (C)
Berdusco, Richard M. (C)
Bria, Frank C. (B)
Carlson, Donald O. (C)
De Malta, Sam (C)
Ghiorso, E. J. (C)
Graun, Darwin (C)
Higgins, Kenneth (B)
Hill, Jess H. (C)
Mannina, Charles (C)
Mollenberg, M. E. (C)
Simpson, Kenneth R. (C)
Sundberg, Ray D. (C)
Tanner, John H. (C)
Walkington, D. F. (B)

SHREVEPORT

Baldwin, A. E. (C)
Parks, Carl E. (C)

SOUTH FLORIDA

Weisner, Glenn L. (C)

SUSQUEHANNA VALLEY

Babecki, Alfred J. (B)

SYRACUSE

Strough, Byron M. (B)

TOLEDO

Greene, Tom M. (C)
Lynn, F. W. (B)

TRI-STATE

Heldt, John J. (B)

WASHINGTON

Huminik, John, Jr. (C)
Ward, James W. (C)

WESTERN MICHIGAN

Schofield, Edmund (B)

YORK-CENTRAL PA.

McKew, Donald A. (C)
Rohrbaugh, Roger L. (B)

NOT IN SECTIONS

Beam, D. C. (C)
Clark, Francis J. (B)
Drayton, Anthony P. (C)
Miller, Barry C. (D)

Members Reclassified

During the month of November

DETROIT

Jones, William A. (C to B)
Paxton, Charles F. (C to B)

NEBRASKA

Dunn, Don J. (C to B)

NEW JERSEY

Bastian, Bernhard J. (D to C)

SUSQUEHANNA VALLEY

Young, Virgil L. (D to B)

●

NEW JERSEY

Correction of name:

"Dippler, John H., Jr. (B)" published in December JOURNAL should have read "Deppeler, John H., Jr. (B)."

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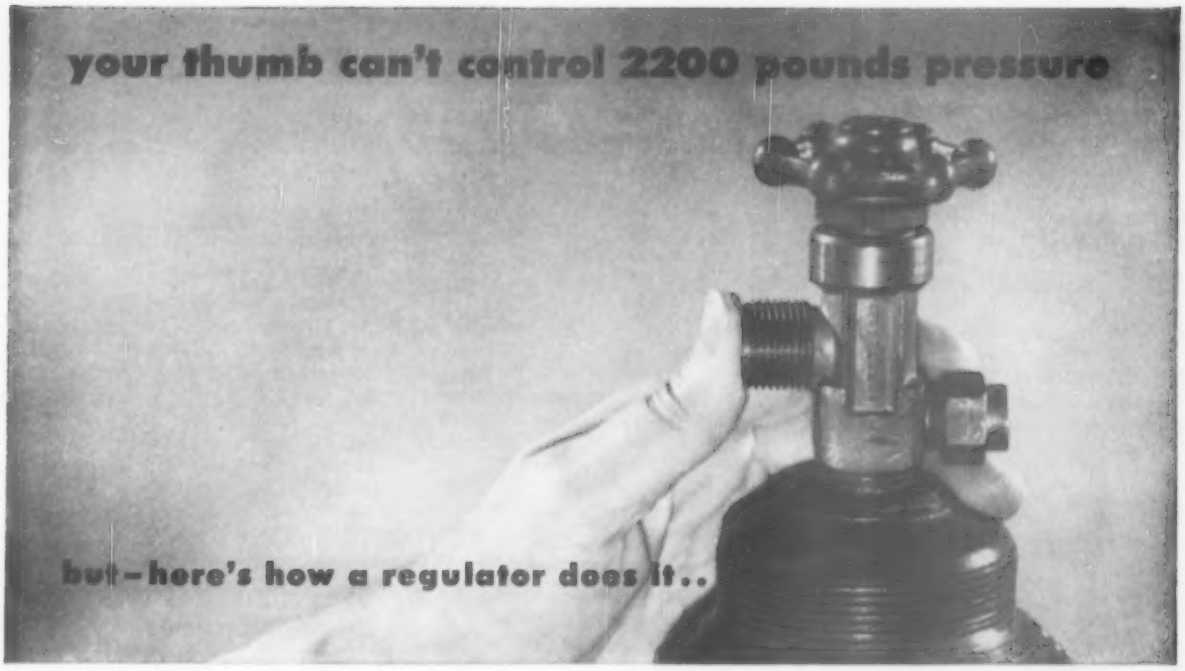

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NEWS of The Industry

Linde Appoints Suydam and Haile to Top Posts

E. B. Suydam has been appointed President of Linde Air Products Co., a Division of Union Carbide and Carbon Corp., it has been announced by Morse G. Dial, president of the corporation. Mr. Suydam succeeds T. D. Cartledge who continues as a vice-president of the corporation.

E. B. Suydam

Mr. Suydam joined the Union Carbide organization in 1916 as a salesman for Union Carbide Sales Co. in New York. He remained with that company until 1928 when he was made manager of the Southwestern Region of Linde Air Products Co., with offices in Kansas City. In 1929 he returned to New York to become Gas Sales Manager of Linde and moved up to the position of General Sales Manager for that company in 1940. He became vice-president of Linde in 1942.

William M. Haile

William M. Haile has been appointed a vice-president of Linde. He joined Union Carbide in 1925 in Linde's Southern Division Office in Birmingham. He moved up through the Linde sales organization to the position of manager of the Eastern Division in 1952. He was on leave to Washington on two occasions, in 1942 to serve with the War Production Board and in 1951 with the National Production Authority.

Mr. Haile was born in New Roads, La. He received the degree of Bachelor of Science from Tulane University in 1924.

Baltimore Distributor Announces Changes

Earlbeck & Landrum, Inc., Baltimore-Washington distributor for the Lincoln Electric Co., are pleased to announce that Charley Basel, formerly head sales technician, is now assisting the owners with purchasing and management problems. Joe Bauer, after four years in the service department, has been promoted to sales technician and taking his place is Howard Bauer who brings with him over 20 years experience as a welder, mechanic and electrician. However, the service department remains under the supervision of Ford Watson, service manager, with his 22 years of knowledge on repairing welders and welding equipment. Mr. Basel is a member of the AMERICAN WELDING SOCIETY.

Also, Earlbeck & Landrum have acquired another 5000 sq. ft of space making a total now of over 14,000 sq ft devoted exclusively to the sales, rentals and repairs of welding equipment.

Personnel Changes Made at Air Reduction

J. W. Kenefic, superintendent railroad service, western region (Chicago office) for Air Reduction Sales Co. Railroad Department, retired after 36 years with the company.

R. L. Rex, superintendent railroad service, eastern region, is appointed superintendent railroad service, Railroad Department, it was announced by D. J. Williams, manager. Mr. Rex will remain in New York City.

Lincoln Increases Remanufacturing Output

The Lincoln Electric Co., Cleveland 17, Ohio, reports that its Linconditioning Division, which remanufactures old welders on a production line basis, has increased its output 45% in the last year. It attributes this increase to the demands the current business boom is making on plants for maximum production and, therefore, the necessity of keeping equipment operating at full capacity.

Metal & Thermit Makes New Appointments

Metal & Thermit Corp. has announced that C. J. Beasley, formerly Controller and Assistant Secretary, has been appointed a vice-president and will plan and direct the financial activities of the company.

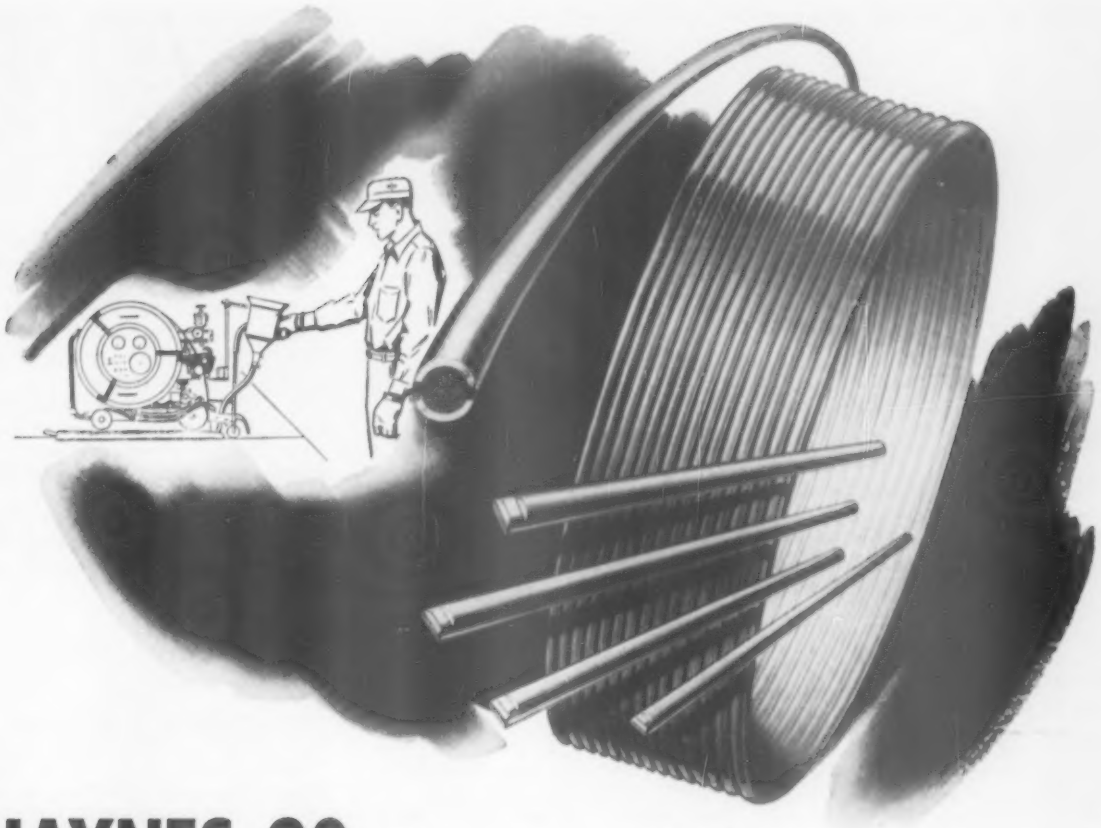
C. R. Hervey, formerly Assistant Controller, has been appointed Controller, succeeding Mr. Beasley in this capacity. Mr. Beasley will retain the title of Assistant Secretary.

Henry Bryk has been appointed as Superintendent of its Thermit Metal Department. He will be located at the Carteret, N. J., plant.

All-State Distributors

New local stocks of All-State Alloys and Fluxes for welding, brazing, soldering, cutting and tinning have recently been established at the following places: California: Ukiah, Superior Oxygen Co.; Illinois: Decatur, D. & R. Welding Supply Co.; Kansas: Coffeyville, Thompson Bros. Welding Supply; Kentucky: Paducah, Hay's Supply Co.; Louisana: Shreveport, Peerless Supply Co.; Maryland: Cumberland, Wilson Welding Supply Co.; Michigan: Manistee, Miller Bros. Iron & Metal Co., Inc.; Minnesota: Windom, Woods Welding Supply Co.; New York: Patchogue, Eastern Distributors; Ohio: Cincinnati, Welders Service & Supply Co.; Texas: Houston, C. F. Myrow Supply; and West Virginia: Bluefield, Pocohontas Welding Supply Co.

Added information may be had by writing to All-State Welding Alloys Co., Inc., 249-55 Ferris Ave., White Plains, N. Y.



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For manual hard-facing, HAYNES 90 tube rod comes in convenient 14-in. lengths for easy application with standard metallic-arc welding equipment. For rapid coating of large parts, HAYNES 90 also comes in coils for mechanized hard-facing by the submerged-arc, inert gas, and open-arc methods.

HAYNES 93, HASCROME, and HAYSTELLITE alloys are also available in this economical tube rod form. HAYNES 93 iron-base rod is noted for high abrasion and corrosion resistance . . . HASCROME iron-base rod for high impact resistance . . . and HAYSTELLITE tungsten carbide rod is tops for resistance to severe abrasion.

For more information about these new, inexpensive tube rods and coils, along with other HAYNES long-wearing hard-facing products, contact your nearest Haynes Stellite Company office today.

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AT THE BALTIMORE WELDING CLINIC

Part of the large group that attended the recent Welding Clinic in Baltimore. Third from right, front row, is George E. Linnert, who was the instructor.

Welder Service Adds to Personnel

Mr. A. H. Homrighaus, Jr., President of Welder Service Company announced today the appointment of Charles W. Boesel to a position with the Welder Service Co. organization.

Mr. Boesel prior to this association was an administrative coordinator for the National Supply Co. for five years. He was also Business Manager for the Toledo Baseball Club from 1946 to 1950. He attended Wittenberg College and the University of Toledo. He is active in Civic projects and various organizations. Mr. Boesel is married and has one child.

Mr. James Follas, who has been office manager and in charge of counter sales for some years will be moved to a position in field sales and engineering work.

Welding Clinic Is Held in Baltimore

The Lincoln Electric Co. and Earlbeck & Landrum, who are Lincoln's distributor for the Baltimore-Washington area, jointly sponsored during November and December another in their series of educational courses entitled "Practical Welding Metallurgy." Once again the instructor was George E. Linnert, Senior Research Engineer for Armco Steel in Baltimore, who recently revised the book "Welding Metallurgy."

A total of six evening lectures were held at the offices of Lincoln in Baltimore and these were attended by 53 men who represented the following prominent local industries: Armco Steel Corp.; Baumiller, Inc.; Bethlehem Steel Co., Key Highway Yard; Bethlehem Steel Co., Sparrows Point Mill; Bethlehem Steel Co., Sparrows Point Shipyard; Allan U. Bevier, Inc.; Charles T. Brandt, Inc.; Buffalo Tank Corp.; H. E. Crook Co.; Crown Cork & Seal Co.; Davison Chemical Co.; Dixie Mfg. Co.; Ellicott Machine Corp.; B. H. Hubbert Co.; Huber Welding Service; Koppers Co.; McNamara & Co.; Maryland Shipbuilding Co.; Novelty Steam Boiler Works; Edw. G. Renneburg & Co.; Revere Copper & Brass Co.; Rheem Mfg. Co.; E. W. Schultz & Sons; Singstad & Baillie, Inc., and Violi Brothers.

The seventh meeting was held on December 6th at the showrooms of Earlbeck & Landrum, Inc., and consisted of practical demonstrations of many of the points covered by Mr. Linnert in his preceding lectures. This welding clinic was attended by over 125 people.

Wisconsin University Sponsors Welding Applications Institute

A Welding Applications Institute will be held at the University of Wisconsin on Feb. 22, 23, 24, 1956. Latest welding equipment, processes and techniques will be discussed by both industry personnel and representatives of equipment manufacturers. The meeting will be of interest to welding engineers, production supervisors, design engineers and maintenance supervisors. The program is designed for both small and large users of welding equipment. For further information, write Engineering Institute, Room 3038, Stadium, University of Wisconsin, Madison 6, Wis.

Airco to Build New Oxygen Plant

A new oxygen plant will be built in Calvert City, Ky., by the Air Reduction Sales Co., a division of Air Reduction Co., Inc., it has been announced by J. H. Humberstone, president of that division. Nitrogen and argon will also be produced at the plant.

This new plant will be completed in the Spring of 1956 and will serve chemical and metalworking customers in the growing Calvert City and lower Ohio valley industrial areas.

Air Reduction acquired 1500 acres of land in Calvert City for the purpose of making plant sites available to customers.

New Jersey Sales Office Opened by GE

The appointment of Henry Keep, Jr., as manager of the General Electric Welding Department's newly established New Jersey sales office and service center located at 750 Fairfield Ave., Kenilworth, N. J., has been announced by E. K. How, manager of sales, Welding Department.

The new facilities will serve the New Jersey and metropolitan New York area, handling equipment, electrodes, accessories, plus complete repair and service facilities.

Mr. Keep is a member of the AMERICAN WELDING SOCIETY.

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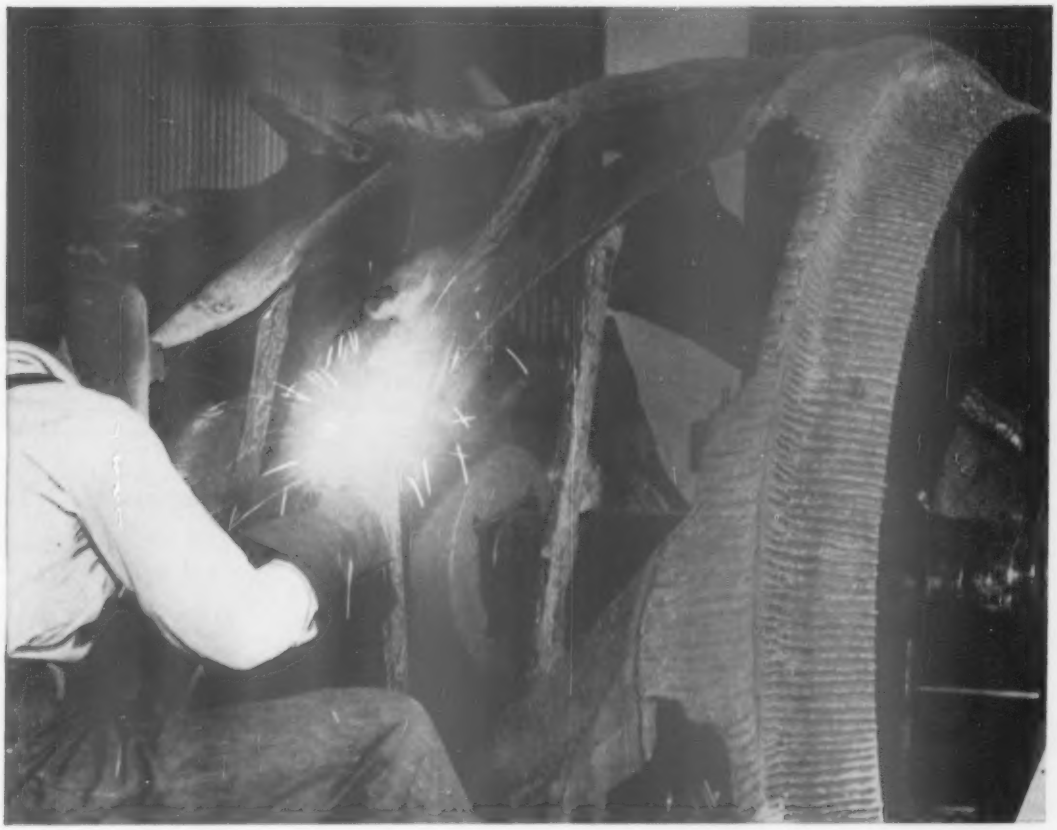
Bring a group from your plant; your up-and-coming young men whom you want to train for important posts; your top production men, too. Everyone will benefit through learning more about welding and its influence on metals engineering.

May 7–11, 1956.



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For copies of articles, write directly to publication in which they appear

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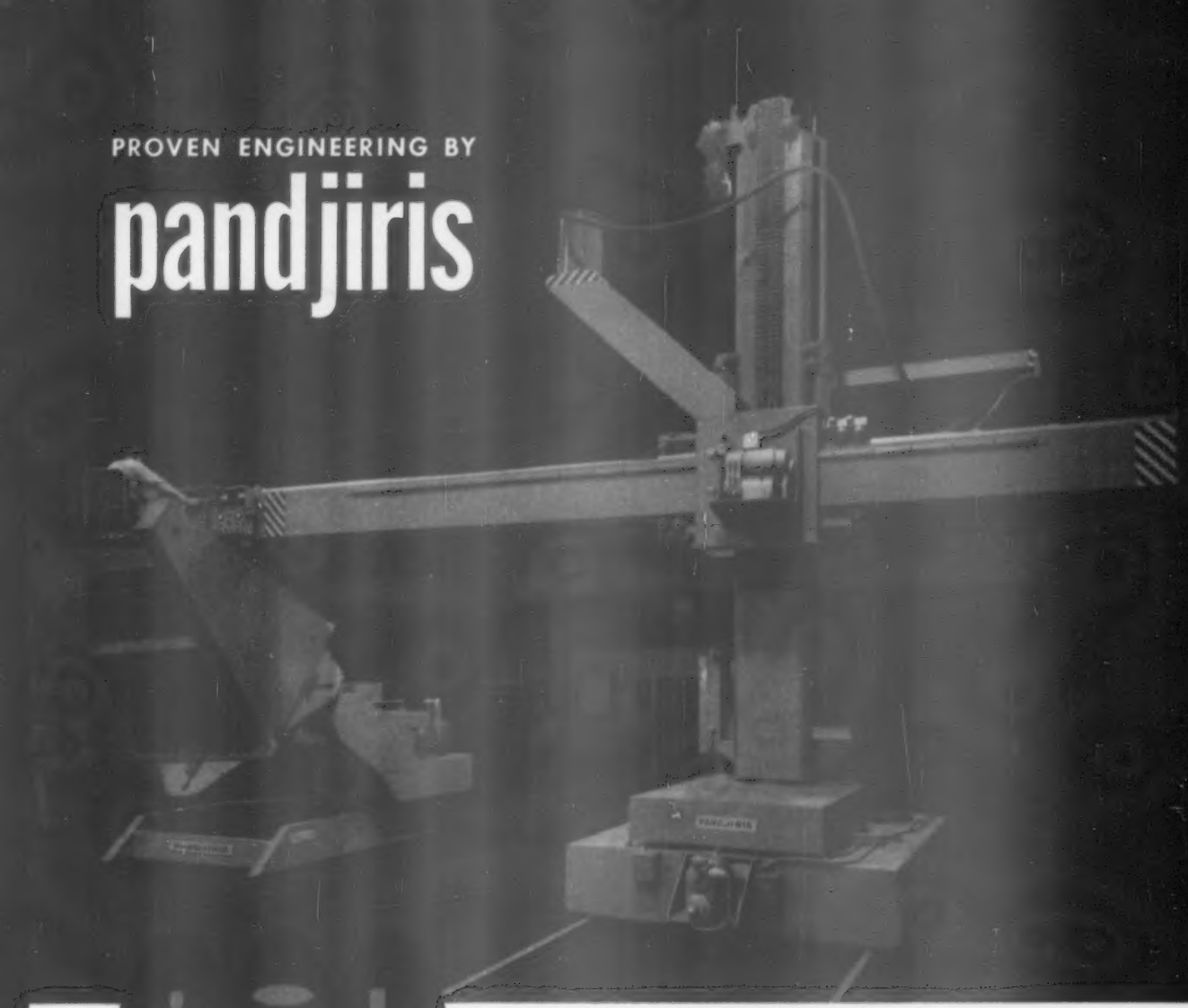

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ABSTRACTS OF CURRENT PATENTS

prepared by V. L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of patents, Washington 25, D. C.

2,725,449—Welding Electrode Holder—Winkler C. Gosch, Hamden, Conn., assignor to Duro Engineering Co., New Haven, Conn., a partnership.

This patented electrode holder includes an electrically conductive handle having terminal means at one end thereof and having a head provided with an electrode-gripping surface at its other end. A jaw is pivoted on the head for movement toward and away from the gripping surface and has an operating arm extending along one side of the handle. Spring means are provided in association with the handle and operating arm to urge the operating arm toward a position so that the jaw is operatively engaged with the gripping surface and any member positioned between such surface and the jaw.

2,725,472—Weld Lockout for Sequence Timers—Edward C. Hartwig, Walnut Creek, Calif., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Pennsylvania.

Hartwig's patent is on a sequence timer for welding apparatus. The apparatus includes means for timing a welding operation, impedance means connected to the timing means to terminate the welding operation when current is supplied thereto, and means responsive to the timing means for supplying current to the impedance means. The sequence timer is characterized by the fact that the responsive means includes a pair of electric discharge paths each defined by an anode and a cathode. Other means connect the paths in parallel to the impedance means. Other means are provided for maintaining the paths non-conductive during the welding operation and the paths are rendered conductive by means responsive to the timing means at the end of the welding operation.

2,725,559—Welder's Helmet—Forrest L. Wagner, Tipton, Iowa.

Wagner's patented Welder's Helmet includes an elongated face mask adapted to stand vertically in front of the welder's face when worn but manually swingable upwardly to a position above the wearer's head. A transparent guard is pivotally mounted on the bottom of the mask and extends rearwardly under the chin of a wearer when the mask is in upright position, but also is adapted to extend into the line of vision for the eyes when the mask is in its upraised position.

2,726,153—Welding Rod—Carl Ballhausen, Krefeld, Germany, assignor to Deutsche Edelstahlwerke Aktiengesellschaft, Krefeld, Germany.

The patented welding rod comprises hard metal composed of one metal carbide and an auxiliary bonding phase of at least one metal of the iron group. In addition to the hard metal, a low-melting point alloy of from 5 to 30% chromium boride and the remainder constituting one metal of the group iron, nickel and cobalt is provided in the rod.

2,726,165—Method of Applying Metal Coating to Valves—William Isler, Cleveland Heights, Ohio.

Isler's patent relates to a method of providing the wearing surface on valves or similar articles with welded-on facings of other protective metal. The method comprises specially supporting a valve, uniformly preheating the valve to raise the seating surface thereof to an elevated temperature at which actual melting of the surface occurs. Powered facing metal, having a melting point in excess of about 2400° F. is substantially uniformly deposited about the seating surface and then the powdered metal is heated to cause it to become fused and bonded to the seating surface and be uniformly distributed thereover.

2,726,308—Welding Method—Lionel Cinamoh, New York, N. Y.

This is a method of spot welding metal sheets and the first step of the process is to apply a liquid suspension of at least about 5% of a finely divided metal of a higher oxidation potential than the metal of the sheets to be welded together, which dispersion is in a hydrocarbon liquid vehicle, to certain desired areas of the sheet. This dispersion is adapted to dry to form a hard, fixed, wholly adherent, continuous film on the coated areas of the sheet. This film coating is contacted with another of the metal sheets to be welded, and an electric welding current is passed through two sheets of metal and the film coating between them until sufficient metal for the spot weld has fused between the sheets.

2,726,309—Cutting and Gouging Torch Using Electric Arc and Gas Stream—Myron D. Stepath, Bremerton, Wash., assignor to Arcair Co., Bremerton, Wash., a partnership.

Stepath's patent is on an electric arc torch including a torch body, electrode holder means on the torch body and gas jet orifice means associated with the holder means. Gas conduit means and valve means are provided in the arc torch for control of flow of gas through and from the arc torch.

2,726,310—Electric Arc-Welding Torch with a Liquid-Cooled Non-consuming Electrode—Jean Brillie, Paris, France, assignor to l'Air Liquide, Societe Anonyme pour l'Etude et l'Exploitation des Procedes Georges Claude, Paris, France.

In the welding torch, a head is provided for holding a nonconsuming electrode. This head includes a cooling chamber formed in part by and surrounding the electrode to carry liquid in direct contact with the electrode. This cooling chamber has a sealing ring surrounding the electrode near an exposed end thereof and comprising a resilient insulating material. Clamping means are provided inside the cooling chamber for securing the electrode and for supplying electric current thereto.

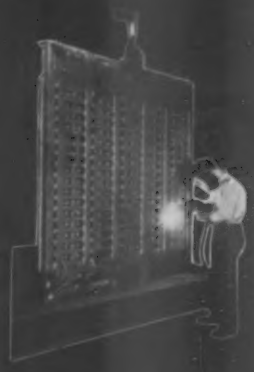
2,726,437—Method of Producing Metal Structures by Welding—Edward Hall Taylor, Winnetka, Ill., assignor to Taylor Forge & Pipe Works, Cicero, Ill., a corporation of Illinois.

This patent is on a method of producing metal rings of nonuniform cross section. The method includes the step of forging a straight metal bar of uniform cross section to the desired final nonuniform cross section of the ring between points adjacent the ends of the bar. The bar is then bent to ring form with the outer ends of the terminal portions of the ring seating against each other and such terminal portions are flash welded together. Then the excess metal is removed from the terminal elements to shape them to the same nonuniform cross section as the forged portion of the ring.

2,726,438—Method of Pressure Welding—Edward Hall Taylor, Winnetka, Ill., assignor to Taylor Forge & Pipe Works, Cicero, Ill., a corporation of Illinois.

This pressure welding method includes steps of disposing the parts with the surfaces to be joined in juxtaposed relation and immersing the parts in a hot inert liquid bath. The parts thus are heated to welding temperature and are then subjected on their surfaces to a high velocity stream of the bath liquid to abrade and clean such surfaces. Then the clean surfaces are forced together at welding temperature and under welding pressure while the parts remain immersed in the bath.

2,726,615—Welding Apparatus—George Downing, Parkersburg, W. Va., assignor to American Viscose Corp.,



WELDING SOLVES ANOTHER WEIGHT PROBLEM

(and USS "T-1" Steel solves the welding problem!)

Bedplates for modern color-printing presses have to be rugged—but as lightweight as possible. They must withstand constant pounding from printing rollers and cutting knives. And, since they move back and forth continually, they've got to be lightweight for fast, efficient operation. It is a good place to use a welded assembly of steel plate.

But that's where Graver Tank & Manufacturing Co., Inc., ran head-on into a tough fabrication problem. Alloy steel with the necessary strength and durability was difficult to weld. And with 534 welds to make on *every* bedplate, this was a king-size headache.

NO MORE HEADACHE!

Now the headache is gone. Production costs are down. And the finished bedplates are working hard and long . . . taking a tremendous daily pounding without distortion.

The solution? Just a switch to a remarkable *new* alloy steel, USS "T-1" Steel.

"'T-1' Steel is very strong. Very tough. Able to take vicious impact abuse. Yet, it's easy to weld," says Mr. H. McDonald, Superintendent at Graver.

HOW ABOUT YOU?

If you have tough jobs, rugged jobs, where you want to weld your way to lower costs, give this new steel a try. We think you, like Mr. McDonald, will find it the best thing you have ever used. Right now, "T-1" is in service and doing well in bridges, power shovels, steam turbines, electrical transformer tanks, flywheels, pressure vessels, mine cars, and lots of other places. Write for details. United States Steel, Room 5087, Pittsburgh 30, Pa.

"TOP QUALITY" That's how Graver Tank & Manufacturing Co., Inc., East Chicago, Indiana, describes new USS "T-1" Steel. It gives them a yield strength of 90,000 psi . . . exceptional resistance to impact abuse . . . and good weldability. It enables them to build extremely rugged, all welded bedplates for printing presses.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST TO COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS

6-15

UNITED STATES STEEL

Philadelphia, Pa., a corporation of Delaware.

Downing's patent is on a welding and metal cladding apparatus which includes a pantograph. A tracer is connected to the pantograph and the container for molten metal is mounted on a bracket associated with the apparatus for lateral reciprocation in the apparatus. A valve is provided on the container for periodically opening to release molten metal from the container, while a torch is mounted to direct a heating flame adjacent the area onto which the molten metal is deposited. Container moving means are provided to move the container sequentially along a devious path for depositing the cladding and welding metal in a desired position.

2,726,616—Portable Welding Machine—George Downing, Parkersburg, W. Va., assignor to American Viscose Corp., Wilmington, Del., a corporation of Delaware.

A self-propelled welding machine is disclosed by the patent. A burner is carried by the machine in a position to direct a flame against the workpiece. A welding rod supply conduit is mounted in the frame for directing a welding rod toward a predetermined area on the workpiece. The apparatus is arranged so that the welding rod is advanced simultaneously with intermittent forward movement of the machine and when the burner is moved to a position away from being directed against the predetermined area of the workpiece on which welding action is desired.

2,727,122—Resistance Welder—Stanley Jacob Gartner, Emporium, Pa., assignor to Sylvania Electric Products, Inc., a corporation of Massachusetts.

In this patented resistance welding apparatus, means support a pair of welding electrodes in operative relationship and other resilient means are provided for urging the electrodes toward each other. Additional means are present to vary the resilience of the resilient means. A further member is provided for varying the stress energy stored in the resilient means. The apparatus is constructed so that the resilience of the resilient means can be varied with substantially no effect on the level of stress energy stored in such resilient means.

2,727,123—Stud Welder—George E. Gregory, Jr., Bay Village, Ohio, assignor to Gregory Industries, Inc., Detroit, Mich., a corporation of Michigan.

A stud welding machine is disclosed in the patent and includes a chuck having means for supporting a welding stud at an end thereof. A ferrule is supported in a position surrounding the welding end of the stud. Other means are present for supplying an inert gas to the space between the shield and the ferrule.

2,727,124—Molybdenum Fabrication—Roy I. Hardin, Chicago, Ill., assignor to Fansteel Metallurgical Corp., North Chicago, Ill., a corporation of New York.

This patent is on a method of producing fabricated molybdenum characterized by crack-free butt welds. The novel method includes positioning edges of a sheet of molybdenum in abutting relationship and arc welding such abutting edges together in an atmosphere of an inert noble gas. The weld action is also performed in the presence of a heat-decomposable hydrocarbon material decomposing under the heat of the arc to form atomic carbon in the region of the weld.

2,727,125—Electric Arc Welding—Albert Muller, Plainfield, N. J., assignor to Air Reduction Co., Inc., a corporation of New York.

Muller's patent is on a gas-shielded-arc-welding method. It comprises establishing an arc from a bare wire electrode to a workpiece and feeding the electrode toward the workpiece to maintain the arc as metal is transferred across the arc from the electrode to the workpiece. The arc is shielded with a stream of shielding gas containing a finely divided solid therein and an outer annular stream of shielding gas is provided for confining the inner stream to bring the solid contained in it into intimate contact with the weld puddle formed by the arc.

2,727,126—Ceramic Gas Nozzles for Welding Torches—Freeman M. Guest and George E. Manis, Huntington, Ind., assignors to Model Engineering & Manufacturing, Inc., Huntington, Ind., a corporation.

This new nozzle comprises an elongated tabular body made of ceramic material having a high melting point and a high electrical insulating characteristic. Such tubular body is reduced in diameter at one end to provide a nozzle and it has an internal recess at its opposite end. A metallic adapter is positioned in such opposite end and it provides a heat dissipating tubular sleeve in the nozzle assembly.

2,727,127—Electrode Holder—Paul D. R. Dority, Bremerton, Wash.

The new electrode holder includes a body provided at one of its sides with a socket for receiving an end of and supporting a welding electrode and other means are provided for securing the electrode in its position engaging with the socket in the body. Other means supply fluid pressure to the holder which has a port therein communicating with the socket which has a port for directing the supplied fluid pressure longitudinally along and in close proximity to the free portion on one side of the electrode.

2,727,483—Method of Forming Can Bodies from Sheet Metal Blanks—William F. Punte, Chicago, Ill., assignor to Continental Can Co., Inc., New York, N. Y., a corporation of New York.

In this patented method of forming a can body, a sheet metal body blank is shaped to provide two seam margins and the seam margins are bent in the same direction and at right angles to the blank after which the body is shaped about a horn and positioned so that the bent seam margins are face to face to form a lapped seam with the bent edges extending radially outwardly from the body wall. These radially projecting portions are spot welded together at spaced intervals after which the welded portions are folded at an acute angle relative to the body wall and forced into intimate contact with the body wall. The edge portions are then solder bonded to each other and to the body wall.

2,727,834—Methods of Brazing and Coating Stainless Steel Parts—Arthur T. Cape, Los Angeles, and Robert E. Jones, La Canada, Calif., assignors to Superweld Corp., North Hollywood, Calif., a corporation of California.

This patent on brazing or coating stainless steel parts to be brazed or coated with nickel-silicon-boron alloys includes the steps of confining the parts to be brazed or coated along with the nickel-silicon-boron alloy in a substantially closed container. Carbon is maintained in close proximity to the parts within the container which is heated to a temperature at which brazing or coating of the parts is effected. A reducing gas is present and reacts with the carbon to create a highly reducing gas within the container until completion of the brazing or coating action and reaction with the heating elements in the furnace or other carburizable furnace parts is avoided.

2,727,969—Welding Apparatus—William N. Platte, McKeesport, Pa., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Penna.

Platte's patent is on a control system for a flash welding machine having relatively movable jaw members for securing members to be flash welded in position. The control includes circuit means connecting the jaw members to a source of flashing voltage and control means are provided and are operable to vary the voltage at predetermined intervals of time in accordance with perdetermined pattern based on an inverse relation with the temperature of the members being welded.

2,727,970—Gas-Shielded Electric-Arc Welding Apparatus—George R. Turbett, Chatham Township, Morris County, N. J., assignor to Air Reduction Co., Inc., New York, N. Y., a corporation of New York.

This apparatus includes a support through which a consumable electrode may be fed and a shell is supported coaxially about such support and defines therewith an annular shielding gas passage. A front barrel fits in telescoping relation with the shell and is axially movable with respect thereto. A water-jacketed nozzle is mounted on such front barrel while an adjustable coolant connection is provided between the support and the nozzle.

Display Your AWS Certificate!

Wear Your AWS Emblem!

Versatile — Dependable

INCO-ROD "A" electrode fills a long-felt need.

It joins many combinations of dissimilar alloys.

Use INCO-ROD "A" electrode to weld mild steel to 304, for example. Or 405 to 304. Or Monel* nickel-copper alloy to 410. Or 347 to Inconel* nickel-chromium alloy.

With each combination, the weld is strong and ductile . . . of X-ray quality. Corrosion resistance and mechanical properties usually equal or exceed those of the base metal. What's more, operability is excellent in any position . . . spray type arc . . . good slag removal.

More than thirty such combinations have been welded successfully with INCO-ROD "A" electrode. Industry is trying many other combinations . . . both between and among ferritic and austenitic stainless steels, low alloy steels, mild steels, high nickel alloys, and other types of alloys.

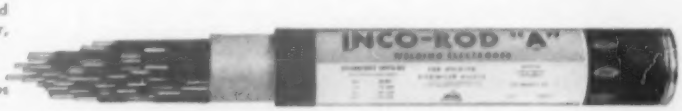
Better than 90% of all such jobs can be handled with this one versatile, new electrode . . . INCO-ROD "A"... the one with the *green* flux coating.

For welding data on *proven* combinations between common alloys, write for 'Announcing INCO-ROD "A"'... a new Inco folder. Be sure, too, to ask about alloys *you* commonly join. New data, not yet published, is constantly coming in from the field.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

*Trade Mark of The International Nickel Company, Inc.

Four convenient sizes handily packed. INCO-ROD "A" electrode is supplied in 14-inch lengths in four diameters, 3/32", 1/8", 5/32" and 3/16-inch (the 3/32-inch is center grip) packed in 5-lb., tubular, asphalt-lined, protective containers (NEMA color coded).



INCO **Welding Products** • electrodes, wires, fluxes

PERSONNEL

Dick Heads Kel-Ray Sales Force

Charles M. Dick, Jr., has been named by Metal & Thermit Corp. to direct its nation-wide staff of sales engineers handling the new Kel-Ray projectors for industrial radiography with gamma rays from radioactive isotopes. Manufactured by the M. W. Kellogg Co., the Kel Ray projectors are sold exclusively by Metal & Thermit.

Charles M. Dick, Jr.

Mr. Dick joins Metal & Thermit after a 19-year career as welder, welding supervisor and welding engineer. Prior to taking his new post he served as Welding Engineer at Todd Shipyards, Houston, Tex.

He is a graduate of the University of Alabama, School of Commerce and Business Administration, and of the Schools of Welding conducted by the Hobart Electric Co. and Lincoln Electric Co.

Mr. Dick is a member of the AMERICAN WELDING SOCIETY and is currently a director of the Houston Section.

Francis A. Dales has been appointed Kel-Ray Sales Engineer at Atlanta, Ga. He comes to M & T from Combustion Engineering Corp., and previously held several positions as a marine engineering officer.

William P. Hoppe, who has represented welders supply houses in the Portland, Ore., area for the past 18 years, has been named Kel-Ray Sales Engineer with headquarters at San Francisco, Calif.

Harold Mears has been appointed Kel-Ray Sales Engineer at Pittsburgh, Pa. He was formerly vice-president of Standard Steel & Wire Co., Bolivar, Pa

Henry C. Opie, for 12 years with the Milwaukee Railroad and for six years Technical Sales Representative for Air Reduction Sales Co., has been named Kel-Ray Sales Engineer in the Chicago area with headquarters at the Metal & Thermit plant at East Chicago, Ind.

Hinchliffe Appointed District Manager

Virgil J. Hinchliffe has been appointed welder district manager of the P & H Washington, D. C., welder territory, according to an announcement by Mr. F. Salditt, vice-president of the Harnischfeger Corp.

This new appointment of Mr. Hinchliffe is in addition to his recent appointment as district manager of P & H in Washington, D. C. He was formerly sales representative of the Washington, D. C., territory for the Harnischfeger Corp. Mr. Hinchliffe will continue to personally travel the Washington-Baltimore and Norfolk territories on P & H welding sales.

Virgil J. Hinchliffe

Mr. Hinchliffe's welding career began in 1933 with a paper company in Pennsylvania. From there he went to the Brooklyn Naval Shipyard. Then in 1941 he received an appointment at the Washington Naval Gun Factory as welding inspector. He joined the Harnischfeger Corp. in 1946 as sales representative for the Washington, D. C., area. In 1949 he was appointed welding engineer for the U. S. Bureau of Ships. After three years, he rejoined the Harnischfeger Corp. He is a member of the AMERICAN WELDING SOCIETY.

Given Is Promoted by IBM

International Business Machines Corp., announces the appointment of John B. Given to Associate Staff Metallurgist in the Metallurgical Laboratory in Endicott. Mr. Given who joined IBM in April 1937, has been associate metallurgist for the past three years.

John B. Given

Mr. Given, a native of Ithaca, N. Y., attended Carnegie Institute of Technology. He is a member of the AMERICAN WELDING SOCIETY. Also, he is this year's chairman of the Southern Tier Chapter of the American Society for Metals.

Marzke Appointed Director of Naval Research

Oscar Theodore Marzke, associate director of research for materials, at the Naval Research Laboratory, Washington, D. C., has been appointed director of research at NRL, Captain S. M.

Oscar T. Marzke

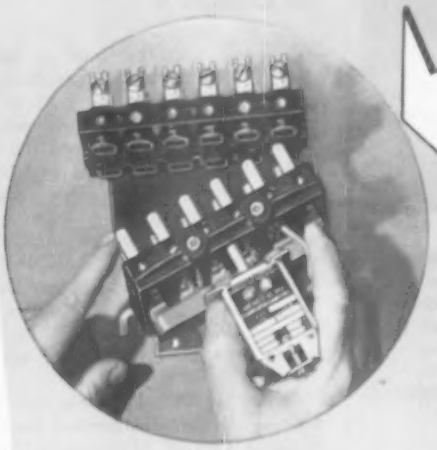
for Better Welding Production...

INDUSTRIAL *Plug-In* UNITS!

Welding Press Control illustrating simple removal of plug-in electronic timer

Plug-In TIMERS

are designed to stand up under hard industrial usage. Both timers and sequencing relays can be installed in a matter of seconds. Down time is reduced to absolute minimum during replacement. Timing circuits are fail-safe—if any tube fails to fire, circuit will be opened and welding process stopped instantly.



Plug-in relays being removed from welding press controller Faster electrical maintenance

Plug-In RELAYS

are of special rugged industrial design and construction. Flexibility provided by plug-in feature (on both sequencing relays and timers), permits easy circuit changes without complete controller redesign.

Write for Bulletin 8991

Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin

SQUARE D COMPANY

JOIN NOW!

If you are interested in better welding, lower fabrication costs and increased productivity, you will gain from investment in AWS Membership. You can learn how to join by writing AMERICAN WELDING SOCIETY, 33 West 39th Street, New York 18, N. Y.

Tucker, USN, director of the Laboratory has announced. He succeeds Dr. Edward O. Hulburt, who is retiring from Civil Service and became the senior scientist for the United States National Committee for the International Geophysical Year of the National Academy of Sciences, on January 1 1956.

A native of Lansing, Mich., Dr. Marzke received his B.Sc. degree in 1929 from Michigan State College and his Sc.D. degree in Metallurgy in 1932 from the Massachusetts Institute of Technology.

Dr. Marzke is a member of the AMERICAN WELDING SOCIETY, American Society for Metals, the American Institute of Mining and Metallurgical Engineers, Tau Beta Pi, the Research Society of America, the British Institute of Metals, the British Iron and Steel Institute and the Washington Academy of Sciences.

OBITUARY

Lorn Campbell, Jr.

Lorn Campbell, Jr., President of the Harris Calorific Co., of Cleveland, Ohio, passed away on Dec. 12, 1955.

Mr. Campbell was born in St. Paul, Minn. His parents were of Scotch extraction. He attended the public schools, and high school of that city, and subsequently the Universities of Minnesota and Cornell.

Lorn Campbell, Jr.

Entering upon his business career, the first venture was in a manufacturing agency, a joint venture with C. K. Rickel, who was his schoolmate in Minneapolis, and who is now the head of the Big Three Welding Equipment Co., of Fort Worth, Tex. Shortly after the birth of that endeavor, both men were given commissions and were called to act as instructors in Oxy-acetylene Welding and Cutting for the army. Their scene of activities was Peoria, Ill. The industry was then young, and their skills were apropos indeed.

Following discharge from the army these gentlemen incorporated the U. S. Welding Co., of Minneapolis, Minn., engaged in the manufacture of Apparatus, and operated a commercial welding shop. Along about 1920 Mr. Rickel went South and set up the Big Three Welding Equipment Co. Mr. Campbell carried on, and in 1926 took over the Harris Calorific Co., in Cleveland. He has been its President and guiding genius over the years.

Mr. Campbell was an active member of the AMERICAN WELDING SOCIETY.

...“it has paid us to use
Meco Welding Equipment
exclusively for the last 25 years.”
RICHARD H. KREMER
President, Kremer-Hicks Co.
St. Louis Heating, Piping
& Air Conditioning Contractor

Famous-Barr, Northland Shopping Center, St. Louis

“Our company recently installed the heating, piping and air conditioning for the new Northland Shopping Center—the largest of its kind in this area. As we do on all jobs, we used Meco Regulators and Torches exclusively.

...“we have found that it has paid us to use Meco Welding Equipment exclusively for the last 25 years. Its dependable, durable construction reduces our down-time to a minimum and the men on the job tell me they prefer it to any other make.”

Richard H. Kremer, President
KREMER-HICKS COMPANY

You'll find—like Kremer-Hicks and so many other outstanding companies—that the extra care and skill that go into all Meco Welding Equipment, pays off in superior workmanship, far less maintenance. Get the facts—write for more information!

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MODERN ENGINEERING COMPANY

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Progressive now offers YOU welding equipment built to your requirements on a TRUE LEASE basis.

Get that equipment you need now! Let it pay its own way.

- **No capital tie-up.**
- **Small cash outlay.**
- **Finest welding equipment built to YOUR specifications.**
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- **No obsolescence problems.**
- **Lease tailored to your situation.**

A sound idea with many advantages for YOU. We will be pleased to give you full details. Write or Phone.

PROGRESSIVE *Welder Sales Company*

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NEW LITERATURE

Hardness Tables

The International Nickel Co., announces the availability of "Hardness Conversion Tables for Steels"—celluloid card, $2^3/_4$ in. x $4^3/_4$ in. This table gives approximate relationship between Brinell, DPH (Vickers), Rockwell and Shore Scleroscope hardness values and corresponding tensile strengths of steels. Data obtained from SAE Handbook. For your copy, write to International Nickel, 67 Wall St., New York 5, N. Y.

Ampco Welding News

The fourth quarter issue of the Ampco Welding News was recently released by Ampco Metal, Inc.

The feature article in this issue describes the use of Ampco-Trode 10 and Ampco-Trode 250 in the repair of a large crank shaft twisting machine at the Erie Forge & Steel Corp. of Erie, Pa.

Copies of this issue can be obtained from Ampco Metal, Inc., 1745 S. 38 St., Milwaukee 46, Wis.

Cutting Machine

A new 20-page catalog describing the operating and construction features of the Airco No. 50 Travograph oxyacetylene multiple-torch, shape-cutting machine is now available from the Air Reduction Sales Co.

Complete information is included covering the accessories such as tracers, regulators, gas distribution systems, the Multi-Bevel Unit, cutting torches and tips.

Request a copy by writing Air Reduction Sales Co., a division of Air Reduction Co., Inc., 60 E. 42nd St., New York 17, N. Y. Specify form ADC 707.

Brazing News

Handy & Harman announced the availability of the latest issue, No. 71, of their pamphlet "Low-Temperature Brazing News." Free copies may be obtained by writing directly to company at 82 Fulton St., New York 38, N. Y.

Steel-Piping Spec

The 1955 edition of this compilation sponsored by ASTM Committee A-1 on Steel contains the latest approved form of 58 ASTM Specifications for ferrous pipe, tubes, castings, fittings, and bolting materials.

Included in these standards, 47 of which have been revised this year, are Tentative Methods and Definitions for Mechanical Testing of Steel Products (A 370), and Classification of Austenite Grain Size in Steels (E 19). Also included in the compilation are American Standards for Wrought Steel and Wrought Iron Pipe (B 36.10) and Stainless Steel Pipe (B 36.19).

Copies of this 432-page publication, heavy paper cover, can be obtained from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., at $4 per copy.

Solder Alloys

A bulletin that lists and describes the application of new special solder alloys for cast iron, aluminum, die cast and stainless steel has been published by Anchor Metal Co., Inc., 244 Boerum St., Brooklyn 6, N. Y., manufacturers of a wide range of solders and fluxes for industrial and home use.

Free copies of the bulletin are available from the manufacturer on request.

Industrial Radiography

New Bulletin P-196, available from Metal & Thermit Corp., 100 E. 42nd St., New York 17, N. Y., describes the new Kel-Ray Projectors for industrial radiography with gamma rays. Manufactured by the M. W. Kellogg Co., and sold exclusively by Metal & Thermit, the projectors are available in three sizes and offer a choice of radioactive isotopes of different intensity.

The 4-page, 2-color bulletin explains how the portability, safety, versatility and economy of the new gamma-ray equipment expands the range of applications in which radiography may be used as a practical, economical tool for nondestructive testing.

Illustrations include photographs of each size projector and drawings showing positioning of the projectors for a variety of radiographic applications.

For your copy of Bulletin P-196, write directly to Metal and Thermit Corp. at above address.

REVIEWS OF NEW BOOKS

Merchant Ships

Design and Construction of Steel Merchant Ships, edited by David Arnott, former Vice-President and Chief Surveyor, American Bureau of Shipping. Price, $15. 494 pages, profusely illustrated. Published by the Society of Naval Architects and Marine Engineers, 74 Trinity Place, New York 7, N. Y.

This book is intended to assist students and others entering the field of shipbuilding toward a knowledge of how merchant ships are designed and constructed and to provide them with a good background for more advanced study. It places a great deal of emphasis on the increased application of arc welding and oxygen cutting to ship construction; also, it incorporates the development of new fire-resisting materials, the latest changes in applying design requirements and regulations and many other topics.

Book is divided into 14 chapters, one of these being devoted to methods of joining structural parts, with particular emphasis on welding.

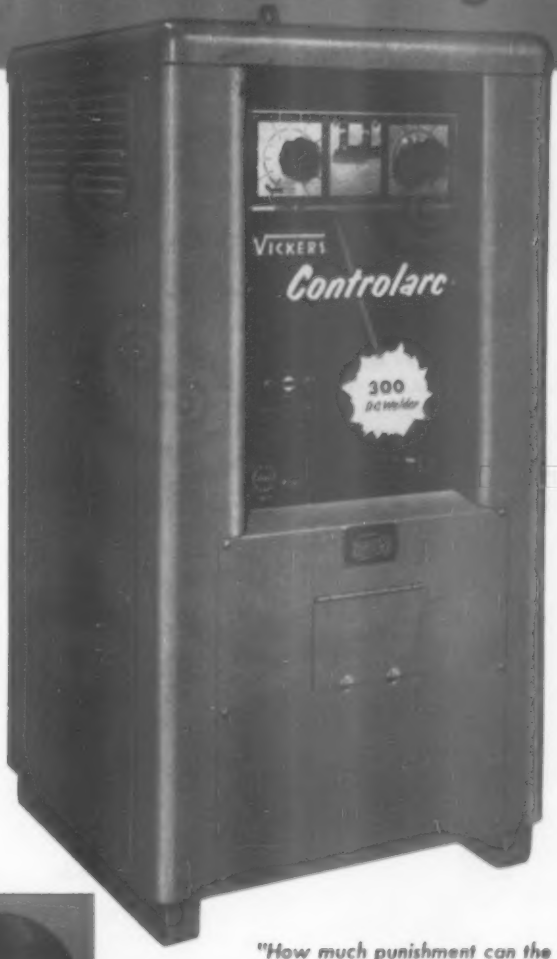
Remember These Dates!

AWS 37th ANNUAL and NATIONAL SPRING TECHNICAL MEETING
May 7–11, 1956 Hotel Statler

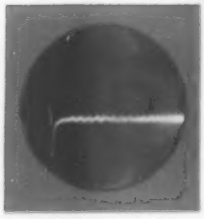
ASME METALS ENGINEERING DIVISION CONFERENCE
May 8–10, 1956 Hotel Statler

AWS WELDING and ALLIED INDUSTRY 4th EXPOSITION
May 9–11, 1956
Memorial Auditorium
BUFFALO, N. Y.

VICKERS® Controlarc DC Arc Welder Survives Punishing "Durability Test"



OVER 1,000,000 CYCLE HIGH-SPEED REPETITIVE ARC TACK TEST EQUIVALENT TO MORE THAN TWO YEARS OF CONTINUOUS USE



This unretouched oscilloscope photograph shows the voltage trace occurring when the arc was broken very quickly during the test, subjecting the CONTROLARC welder to severe abuse.

"How much punishment can the Vickers CONTROLARC DC Welder take?"

Vickers engineers decided to find out.

A 200-ampere CONTROLARC was subjected to a gruelling durability test. Every nine seconds the welder was charged with a six-second load of 250 amperes (50 amperes above rated capacity) at 27.5 volts. After 198,900 "makes" and "breaks" the load was boosted to 300 amperes at 27 volts. When the test was concluded the CONTROLARC had survived 1,004,522 of these charges, *and was still going strong*—with no apparent effect on any part of the welder. This test simulated arc tacking on production at 4 tacks continuously per minute on an 8-hour day basis for over two 300-day years.

For complete information about this rugged, dependable welder, write today for new bulletin.

Some territories open for qualified dealers. Write for details.

VICKERS ELECTRIC DIVISION

VICKERS Inc. a unit of Sperry Rand Corporation

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NEW PRODUCTS

Portamatic Pacer

A new attachment for seminutomatic welders, named the Portamatic Pacer, has been designed and manufactured by Edgar Carlson, owner of the Carlson Manufacturing Co., 195 W. Carson St., Pittsburgh 19, Pa.

According to the manufacturer, the new machine has been built with the objectives of assuring pinpoint welding accuracy and smoother welds with a minimum of distortion at speeds up to five times faster than by conventional methods.

Made of aluminum, stainless steel and brass, the Portamatic Pacer is equipped with an all-sealed d-c aluminum motor controlled by an inch button on the handle. The unit weighs 3 ½ lb.

For complete details, write directly to manufacturer at above address.

Brazing Alloy

A new nickel-base brazing alloy which is said to feature unusually low brazing temperature, self-fluxing properties, thin to moderate fillet formation and no erosion during brazing is now available from Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.

This nickel-phosphorous material, called Nicrobraz No. 10, is recommended for low-temperature joining of stainless steels, nickel-base alloys and cobalt-base alloys, as well as low-alloy steels, carbon steels, copper and other base metals having a melting point above 1900° F, in applications involving service temperatures from 60 to 1500° F.

Nicrobraz No. 10 Powder is easily applied with a suitable brush or applicator after mixing with Nicrobraz Cement. With the proper mixture ratio, the new brazing alloy can also be applied by either cold spraying or hot spraying methods.

Complete details may be had by writing directly to company at above address.

Plate Clamp

The Porto-Magnetic Plate Clamp, distributed by Portomag Sales, Inc., of 1511 E. Nine Mile Rd., Ferndale 20, Mich., is a lightweight, self-contained unit, combining a powerful magnetic base and a fast operating jack.

According to the manufacturer, butt welding of heavy plates by a single operator is easily accomplished. The Porto-Magnetic Plate Clamp is first placed with the jack over the warped plate. The instant the current is turned on, a few fingertip turns of the ratchet lever, and proper alignment results. Lap welding is done in the same manner.

It is claimed that the use of the Porto-Magnetic Plate Clamp eliminates the need for welding supporting clamps or driving wedges.

Write directly to Portomag Sales for complete information.

Cleaning Brush

Air Reduction Sales Co., has announced the availability of a new stainless steel wire scratch brush for cleaning stainless weld beads. This brush will eliminate the possibility of oxidation of the stainless parent metal caused by using standard steel scratch brushes.

For more information about this new brush, write Air Reduction Sales Co., a division of Air Reduction Co., Inc., 60 E. 42nd St., New York, N. Y.

Mild Steel Electrode

A general purpose high-speed, low-slag electrode designed especially for the operator who has a variety of mild steel welding requirements is announced by All-State Welding Alloys Co., Inc., 249–55 Ferris Ave., White Plains, N. Y. Low-amperage (40 to 225 amps) deposits from this electrode exhibit a tensile strength of 65–75,000 psi, a yield strength of 58–63,000 psi and a 26–34% elongation in 2 in.

This new electrode is designated as the All-State Steelarc. It is applicable with a-c or d-c welders. It is particularly recommended by the manufacturers for steel fabrication requiring its high strength, e.g., boilers, tanks, pressure piping, rugged equipment, vehicle bodies, bridges and railroad cars. Steelarc can be used also for poor-fit work and dissimilar sections as light or heavy sheet to castings.

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- Visible glass anode seal making observation of firing simple
- Insulating shield around ignitor terminal
- Rugged, stainless and alloy steel construction

There's an AMPEREX distributor in all principal cities. Write direct to factory for data sheets and name of distributor nearest you.

Amperex ELECTRONIC CORP.

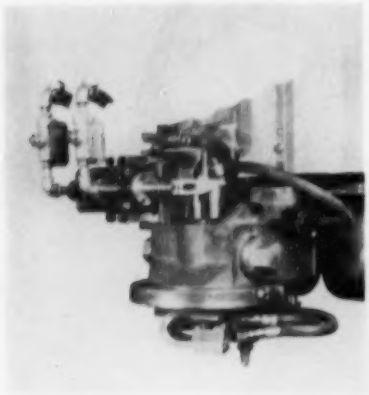
230 Duffy Avenue, Hicksville, Long Island, N. Y.

In Canada: Rogers Majestic Electronics Ltd.
11-19 Brentcliffe Road, Leaside (Toronto 17)

Complete details may be had by writing directly to the company at the above-mentioned address.

Stitch-Welding Head

The new Taylor-Winfield stitch-welding head guides spot-welding electrodes to achieve contoured seam welds previously unobtainable on any automatic equipment, according to the manufacturer.



Either spaced or overlapping spots on any contour pattern may be used, permitting more freedom in product design than has previously been available. The stitch head may be mounted on any press welder and replaces the upper electrode.

For more complete details write to the Taylor-Winfield Corp., Warren, Ohio.

Flame-Resistant Curtains

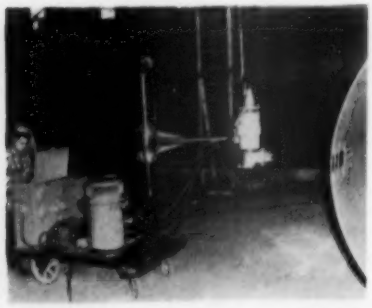
Flame-resistant curtains and blankets, made from impregnated canvas and designed to provide protection from intense heat, arc flash, molten splash, flying chips and scale, are being offered by Eastern Equipment Co., Inc., Willow Grove, Pa. These curtains and blankets are used to screen off arc-welding operations and can also be made into inexpensive booths to screen off any other dangerous operation, wherever required. Dimensions, weight of canvas and number and placement of grommets are determined in accordance with customer's specifications. Complete details can be obtained by writing to Eastern Equipment Co., Inc., Willow Grove, Pa.

X-Ray Unit

The accompanying illustration shows an application of the new Norelco MG 150 X-ray unit for seam inspection at the plant of the Delta Tank Mfg. Co., Inc., at Baton Rouge, La.

The MG 150 uses a high-current tube that can be operated at constant potentials up to 150 kv and at currents up to 20 ma.

In the photo, the unit is set up to X-ray a longitudinal seam. Film is



taped inside the tank shown at the extreme right. A different Norelco tube called a rod anode unit is used for girth seams which are checked with one exposure. On such work, film only $2^3/_4$ inches wide is employed.

For complete details write to North American Philips Co., Inc., 750 S. Felton Ave., Mount Vernon, N. Y.

A-C, D-C Arc Welders

Manufacture of two series of a-c, d-c arc welders has been announced by Miller Electric Mfg. Co., Inc., Appleton, Wis.

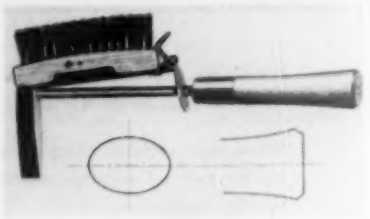
The SRAC Series are designed for metallic arc welding, these are available in 200-, 300- and 400-amp ratings, with or without power factor correction.

The SRTA Series are designed primarily for inert gas and inert-gas spot-welding processes. SRTA welders are available in 200- or 300-amp models and all are power factor corrected.

Both series of these a-c, d-c welders operate from a single-phase power line, and current can be controlled remotely at the welding position.

Cleaning Tools

A new wood grip has been developed and is now being furnished on their wood grip, steel shafted Tomahawks and "Dual Tools" by Atlas Welding Accessories Co., Ferndale, Mich.



The new grip is egg-shaped to fit the hand naturally and line up the chipping edge and is belled slightly toward the end to prevent the tool slipping out of the hand. The handles are made from #1 "Ozark" Hickory with wax finish.

For complete details write directly to manufacturer at above address.

Inert-Arc Welding Torch

A new air-cooled Heliarc torch for inert-gas shielded-arc welding of light metals has been developed and introduced by Linde Air Products Co., a Division of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y. The new HW-17 torch, with a continuous-duty current capacity of 130 amps (150 amps for a reduced-duty cycle), is the highest capacity air-cooled torch of its kind on the market, according to the manufacturer. Lightweight and easy to use, the HW-17 will join mild steel and hard-to-weld

metals like aluminum, magnesium, stainless steel, Monel, Everdur, copper brass, and high-alloy steels.

The HW-17 can be used with high-frequency stabilized alternating current as well as straight or reversed polarity direct current.

For additional details, write directly to Linde at New York address.

High-Temperature Brazing Flux

A new high-temperature brazing flux is now available from Air Reduction Sales Co. This flux has been produced to meet the need for high-temperature brazing of chrome and nickel alloys. The stainless steel assemblies used in jet aircraft, automotive, pharmaceutical, and nuclear energy industries are particularly good applications for this new flux, according to the manufacturer.

It is free flowing and active in a temperature range of 1400 to 2000° F.

For more information about this new high-temperature brazing flux, write Air Reduction Sales Co., a division of Air Reduction Co., Inc., 60 E. 42nd St., New York 17, N. Y.

Metallizing Machine

One of the unique engineering features claimed for the new Vanco Metallizing Machine is a dynamically balanced air turbine which provides a positive power control uniformly feeding metal wire without fluctuation, an important factor in the operation of a metallizing machine.

According to the manufacturer, the turbine is automatically governed by

the propulsion fluid supplied to the primary and secondary turbine.

Manufactured and distributed by the Vandersee Corp., Route 22, Union, N. J.

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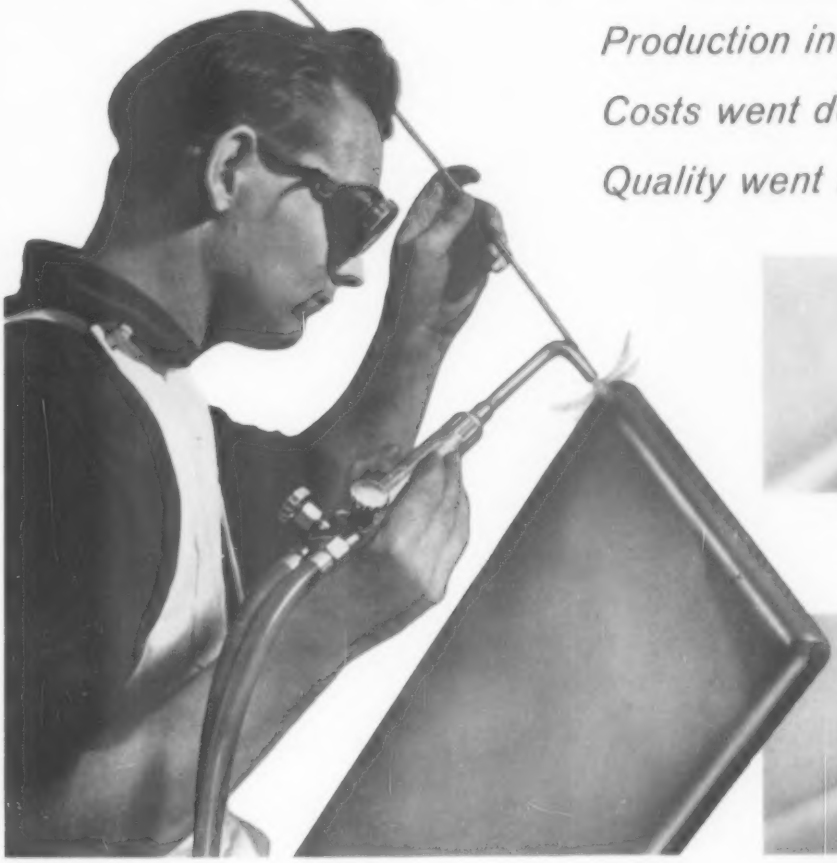
When Revo-File Co. switched to braze welding with Anaconda Rods

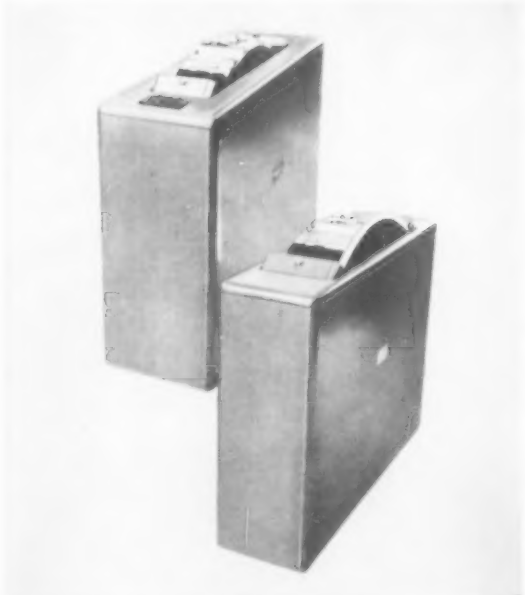
Production increased

Costs went down

Quality went up



Close-up of braze weld in panel corner. Panels are #18 gage mild steel. **Below:** A corner after sanding – the basis for a smooth, perfect enamel finish.



Revo-Files, marketed by the Mosler Safe Company. Unit at left is electrically operated – a touch on a button brings desired section of revolving file into place. Right-hand unit is manually operated. Corners of top and two end panels, plus seams on the locking covers, are braze-welded.

14 superior braze welds in 7 minutes

The Revo-File Company of Freeport, L. I., used to arc-weld panel corners and locking-cover seams on its revolving-file cabinets. But they were troubled by lack of penetration and by considerable porosity.

About six years ago, the Company turned to oxyacetylene braze welding, using Anaconda-997 (Low Fuming) Bronze Rod. They found that the rod flows smoothly, is easy to control – reducing the time required to make the welds. It takes only 7 minutes to complete 14 welds, an average of 30 seconds per weld.

In addition, the welds are uniformly sound and well-formed, reducing finishing time. Thus, for Revo-File Company, the switch meant better product quality, lower costs, and increased production.

Anaconda-997 (Low Fuming) Bronze is a superior welding rod used to join gray and malleable cast iron, steel, and copper alloys by the oxyacetylene process. It is one of a broad line of Anaconda Welding Rods that are finding increasing applications in production and repair welding. Anaconda Welding Rods are sold by distributors of welding equipment everywhere. Whitehead Metal Products Co. of New York furnish Revo-File Co. with Anaconda rods. See your Anaconda distributor or write: The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 55147

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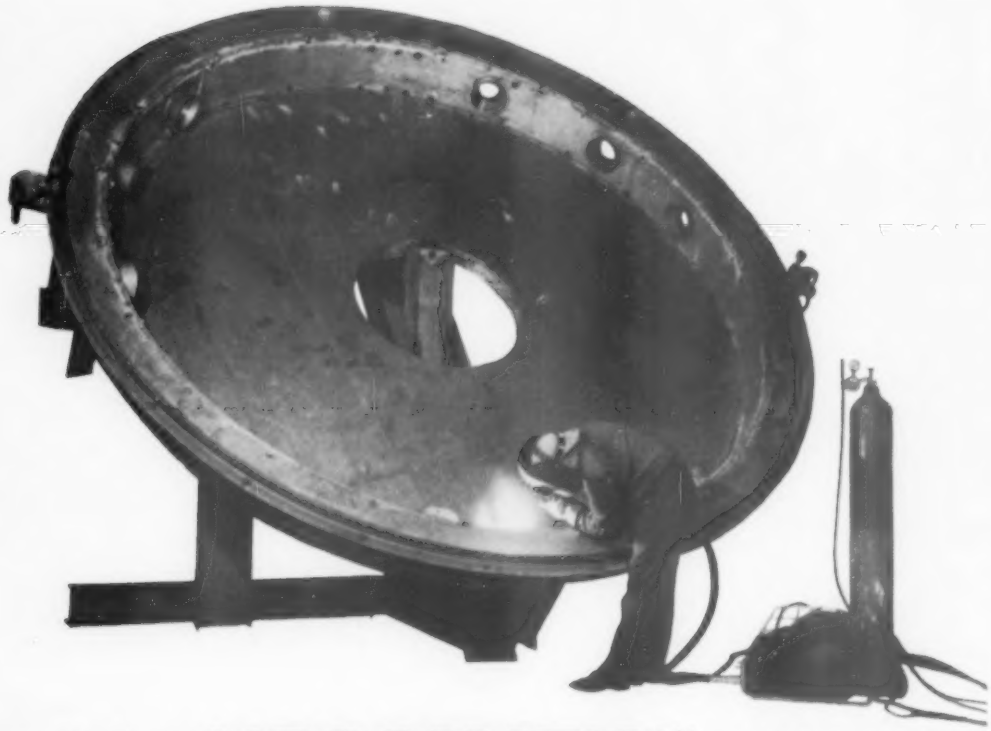

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An Airco Representative can give you a completely unbiased opinion as to how Aircomatic can best be employed – because – Airco is a leading manufacturer-supplier of all types of oxyacetylene, metallic arc and inert-gas shielded welding and flame cutting processes, their controls, supplies, and accessories.

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